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The
NATURALIST'S,
and
TRAVELLER'S COMPANION,
Containing
Instructions for collecting & Preserving Objects of
NATURAL HISTORY,
and
for promoting inquiries after Human
Knowledge in General.

the Second Edition corrected & Enlarged.

BY John Coakley Lettson M.D. F.R.S. & S.A.



LONDON: Printed for E. & C. Dilly, 1774.

TO THE GREAT
L I N N Æ U S,
THE FOLLOWING
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THE

P R E F A C E.

“**H**E that enlarges his curiosity after the works of nature,” says a celebrated writer, “demonstrably multiplies the inlets to happiness. A man that has formed a habit of turning every new object to his entertainment, finds in these productions an inexhaustible stock of materials upon which he can employ himself, without any temptations to envy or malevolence; faults, perhaps, seldom totally avoided by those, whose judgment is much exercised upon the works of art. He has always a certain prospect of discovering new reasons for adoring the sovereign author of the universe, and probable hopes of making some discovery of benefit to others, or of profit to himself.”

No method appears better calculated to enlarge our knowledge of Natural History, than visiting foreign countries, and carefully attending to the different objects they afford, which more or less delight by their novelty and variety; but our inquiries should not be confined merely to private gratification; there are duties of a more rational nature; to be useful to

society by distributing happiness amongst our fellow creatures, is one of the highest and most necessary. The numerous products of nature, their application to the wants, the comforts and even ornaments of life; the manners, customs and opinions of mankind; agriculture, manufactures, and commerce; the state of arts, learning, and the laws of different nations, when judiciously investigated, tend to enlarge the human understanding, and to render individuals wiser, better and happier.

The introduction of the common potatoe, the management of silk-worms, the discovery of jesuits bark, the uses of cochineal, Lacca and Indigo, are undeniable proofs of the advantages which might be derived from the inquiries of ingenious men. The discovery of another such root as the potatoe, another such article of commerce and apparel as silk, another such remedy as the bark, and such other dyeing articles as cochineal and indigo, would prove acquisitions of the greatest importance to a trading nation, and render the inquisitive traveller conspicuous as a public blessing.

Many gentlemen and sea-faring persons who go abroad, by their office and situation in life, enjoy both time and opportunity for collecting the best information

on such subjects of general utility, especially the natural productions peculiar to the place they visit or reside in, which they are induced to overlook for want of proper directions for distinguishing and preserving them, whereby things of value and use are lost to the public, and the time of the traveller less beneficially employed.

To promote an application of the time and talents of such persons to rational and commendable inquiries of this kind, is the design of the following directions, which the author thinks himself justified in recommending, as they principally result from experiment and observation: These were first published about twelve months ago, and the reception from the public hath been such, as renders another edition requisite, while it intimates the utility of the original plan, which has since been considerably improved, to make it more deserving of future encouragement.

The second part is intirely new, in which are introduced several queries and observations on natural history, and upon subjects in general, which have not been clearly and sufficiently ascertained, and therefore merit the attention of the Naturalist and Traveller. For this part of his publication, the author acknowledges himself

self principally indebted to the ingenious John Reinhold Forster, who obligingly presented to him many of his manuscript papers, previous to his departure on the present expedition to the South Seas. He has also the pleasure to mention his obligation to the celebrated Linnæus, and other correspondents, who have favored him with their observations on different subjects of natural history.

Several treatises however have been written on the plan of the first part; some years since, M. Turgot published his “*Memoire instructif sur la Maniere de rassembler, de preparer, de conserver, et envoyer les diverses Curiosités d’Histoire Naturelle*, Lyons, 1751. 8vo.” with figures; but the directions it contains are prolix, and in many respects injudicious; so ignorant is the author of a proper method of preserving insects, that he directs the collector to place them betwixt leaves of paper (pag. 88.) similar to the recommendation of Petiver.

In the “*Amoenitates Academicæ*,” published in 1753. under the sanction of the great Linnæus, Dr. Hultman gives his *Instructio Musei Rerum Naturalium* in a very intelligent manner, though in a language which renders this ingenious production of less general utility.

My friend John Reinhold Forster wrote his directions for collecting, preserving and transporting all kinds of natural history curiosities, in 1771. This performance, though a work of merit, is too concise for the purpose designed; and the author's method of preserving birds is not justified by experiment, as it will neither secure such subjects from insects, nor admit of their receiving a natural position.

Other writers have also appeared in different departments of Natural History, the principal of which will be noticed under the particular heads they treat upon.

If persons who go abroad, or reside in foreign countries, were acquainted with mathematics and drawing, they would in all probability make their remarks more acceptable, by adding accurate maps of the countries they visit or reside in; and by joining to them the drawings of men, their dresses, utensils, weapons, coins, machines, rites, sacrifices, buildings, temples, idols, and antiquities; as well as the curious quadrupeds, birds, reptiles, fish, insects, and shells peculiar to each place; with the plants found in those climates, especially such as are employed for food, in commerce, manufactures, physic, dyeing and other purposes.

In the drawings and descriptions relative to natural history, it is necessary
to .

to attend to many circumstances which are the characteristics of each species of the animal and vegetable creation. In quadrupeds the number and disposition of the teeth; shape and position of the horns; number of the toes in each foot; shape and size of the claws and hoofs; size of the ears; color and disposition of the whiskers; nature and growth of the hair in the fur, mane and tail; length and uses of the tail; whether calculated to grasp any object, or to give the animal stability; and even the attitude which is characteristic of the animal, and shews best its marks, spots, stripes, claws, ears, tail, &c. ought to be expressed.

In birds, the shape and uses of the bill, whether notched, serrated, or otherwise remarkable; number and disposition of the toes, and whether distinct, lobated, or palmated; length of the legs and nakedness of the knees; color of the greater and smaller quill feathers, upper and under coverts of the wings; number and color of the tail feathers, and coverts of the tail; appearance of the vent, belly, breast, throat, back, crest, wattles, carunculæ, spurs, &c; attitude peculiar to the bird, and the difference between males and females, and young and old birds, should be described.

In

In tortoises or turtles the disposition of the shell, and its compartments; shape and number of its toes; absence or presence of the tail, and shape of the head, must be delineated.

In snakes, the scales above and below, their number, color, and figure; form of their heads, and whether they are venomous, should be remarked.

In fish, it is necessary to attend to the proportion of the breadth to the length; form of the head and disposition of the palate and teeth; shape and position of the mouth; size and situation of the eyes; coverts of the gill, and rays of its underpart; spines, horns, and protuberances of the head; number, figure, size and color of the fins and tail, with the spinose and soft rays in each; the turn of the lateral line, with the form, color and disposition of the scales.

In insects, the season when each of the different kinds appear should be observed; the number, substance, and particular shape of their wings, with the position of them when the insect is at rest; the shape of the antennæ or horns, with the number of joints in each; the form of the head, mouth and eyes, more particularly of the head in beetles, of the mouth in bees, wasps, flies and gnats, and of the eyes in spiders; the number and size of the legs;
the

the shape of the thighs, feet and claws ; the stings peculiar to the hymenoptera class, and the uses they are applied to : but the natural history of insects should in a peculiar manner engage the traveller's attention, as it is of more consequence to discover the natural history of one destructive or useful insect, than merely to collect and bring over twenty in their perfect state ; the former, at the same time that it makes the science more entertaining, bids fair to benefit mankind, while the latter serves only to fill the cabinets of the curious ; he should therefore carefully observe the manner in which insects copulate, and the places where they deposit their eggs ; what food the young larvæ or caterpillars feed upon ; if vegetable, whether it be the root, trunk, leaf, flower or fruit ; if destructive, as they mostly are, the methods used by the natives to destroy them ; and if useful, the means of cultivating them ; and what are their natural enemies ; the form, attitude and markings of the caterpillar, should be described ; if it has feet, their number, and the particular rings on which they are situated ; whether it be smooth, hairy or spinous, and the manner of its changing into the chrysalis or pupa state, and how long it continues before it arrives to perfection, with the various instincts and

con-

contrivances they have for avoiding dangers and catching their prey.

In shells, not to neglect the number of them belonging to one animal; when single, the turn in the windings, whether to the right or left; the stripes, spots, bands, knobs, spines, furrows and other marks; shape of the mouth or opening of the shell, lips and beaks: In those that have two or more valves, their equal or different sizes; the form of the hinges where they are connected, and the number of indentures tallying together; the stripes and furrows on the outsides, and whether longitudinal or transversal; and the animals inhabiting the shells should likewise be observed and delineated.

In the rest of the worm tribe, the shape, arms, and other parts of the animal should be delineated.

In plants the greatest accuracy is requisite, the shape of the flower being so varied, nice attention is necessary to distinguish its minute parts; the figure and number of the flower leaves; the form and sections of the flower-cup; the number and disposition of the dust vessels, and of the columnar vessels standing on the fructification (which are reckoned by botanists to be the male and female parts of the flower, and in some instances are on different plants; in others on the same plant,

plant, but in different parts of it); the shape, structure, and color of the stalk and leaves; the appearance and structure of the roots, and such other circumstances as characterize the different species of plants, ought never to be omitted.

The Naturalist should likewise endeavour to keep an accurate journal, wherein all the occurrences, observations, places, distances, descriptions, accounts, informations, and remarks, should regularly and daily be entered, while recent in memory.

T H E

THE
NATURALIST'S
AND
TRAVELLER'S COMPANION.

PART the First.

SECT. I.

*The Method of catching and preserving
INSECTS for Collections.*

————— Ten thousand different tribes
People the blaze. To sunny waters some
By fatal instinct fly.

————— Through the green-wood glade
Some love to stray; there lodg'd, amus'd and fed,
In the fresh leaf. Luxurious, others make
The meads their choice, and visit every flower,
And every latent herb. (a)

INSECTS in general are known to most people, the systematic distinctions but to few; nor have we any English names for the greatest part of them. The general denomination of beetles, butterflies, moths, flies, bees,

(a) Thomson's Seasons, Summer, l. 246.

B

wasps,

wasps, and a few other common names, are all that our language supplies. It would, therefore, be in vain to enumerate the immense variety of genera and species to any person unskilled in the science of entomology: we may, however, give directions under general names, where to find and how to catch each kind. (*b*)

I. The Coleoptera (*c*), or first great class of insects, including beetles, are found in and under the dung (*d*) of animals, especially of cows, horses, and sheep: many of them make holes under the dung three or four inches deep; it will therefore be necessary to have an iron spade to dig them out, when in search of this tribe of insects.

Some (*e*) are found in rotten and half decayed wood, and under the decayed bark of trees; on the carcases (*f*) of animals that have been dead four or five days; on moist bones that have been gnawed by dogs or other animals; on flowers having a foetid smell; and on several kinds of fungous substances, particularly the
rotten

(*b*) Vide Schoeffer. *Elementa Entomologica*. Curtis's accurate instructions for collecting and preserving insects, and his introduction to the knowledge of insects, translated from the *Fundamenta Entomologiæ* of Linnæus. *Amæn. Acad.* v. 7.

(*c*) Coleoptera, from *κολεδος*, a sheath, and *πτερον*, a wing, are such insects as have crustaceous Elytra, or shells, which shut together, and form a longitudinal suture down the back of the insect, as the beetle, *Buprestis ignita*, fig. 1.

(*d*) Scarabæus, *chafer*. Dermestes, *leather-eater*. Hister, *mimick-beetle*. Staphylinus, *rove-beetle*. (*e*) Lucanus, *stag-beetle*. Cerambyx, *capricorn-beetle*. Dermestes. (*f*) Hister. Silpha, *carion-beetle*. Staphylinus.

(*g*) Byrrhus,

rotten and most stinking: others (*g*) may be found in a morning about the bottoms of perpendicular rocks and sand banks, and also upon the flowers of trees and herbaceous plants.

Many kinds (*b*) may be caught in rivers, lakes, and standing pools, by means of a thread net, with small meshes, on a round wire hoop, fixed at the end of a long pole.

In the middle of the day, when the sun shines hot, some (*i*) are to be seen on plants and flowers, blighted trees and shrubs; others (*k*) in moist meadows are best discovered at night, by the shining light which they emit.

A great variety (*l*) fit close on the leaves of plants, particularly of the burdock, elecampane, coltsfoot, dock, thistle, and the like; or feed on different kinds of tender herbs (*m*).

Numbers (*n*) may be found in houses, dark cellars, damp pits, caves, and subterraneous passages, or on umbelliferous flowers (*o*), on the trunks as well as the leaves of trees; in timber-yards, and in the holes of decayed wood.

Some (*p*) inhabit wild commons, the margins of pools, marshes, and rivulets; and are likewise seen creeping on flags, reeds, and all kinds of water-plants.

Multitudes (*q*) live under stones, moss, rubbish, and wrecks near the shores of lakes

(*g*) *Byrrhus*, *curculio*, *weevil*. *Bruchus*, *seed-beetle*. (*b*) *Gyrinus*, *whirl-beetle*. *Dytiscus*, *water-beetle*. (*i*) *Coccinella*, *lady-fly*. *Buprestis*, *burn-cow*. *Chrysomela*, *golden-honey-beetle*. *Cantharis*, *soft-winged-beetle*. *Elatér*, *spring-beetle*. *Necydalis*, *clipt-winged-beetle*. (*k*) *Lampyrus*, *glow-worm*. (*l*) *Cassida*, *tortoise-beetle*. (*m*) *Meloe*, *blister-beetle*. (*n*) *Tenebrio*, *stinking-beetle*. (*o*) *Cerambyx*, *Ptinus*. (*p*) *Leptura*, *wood-beetle*. *Cicindela*, *glossy-beetle*. (*q*) *Carabus*, *ground-beetle*.

and rivers. These are found also in bogs, marshes, moist places, pits, and holes of the earth, on stems of trees; and in an evening they crawl plentifully along path-ways after a shower of rain.

Some (*r*) may be discovered in the hollow stems of decayed umbelliferous plants, and on many sorts of flowers and fruits.

II. Another class (*s*) of insects are found about (*t*) bake-houses, corn-mills, in ships, and in all places where meal is kept; on grass (*u*), and all kinds of field herbage. Some (*v*) of these frequent rivers, lakes, and standing-pools.

III. Butterflies and moths make another great division (*w*). In the day, when the sun is warm, butterflies (*x*) are seen on many sorts of trees, shrubs, plants, and flowers. Moths (*y*) may be seen in the day-time, sitting on walls, pales, trunks of trees, in shades, out-houses, dry holes, and crevices; on fine evenings they fly about the places they inhabit in the day-time: some (*z*) are seen flying in the day-time over the flowers of honey-suckles and other

(*r*) Forficula, *earwig*.

(*s*) Hemiptera, from ἡμισυ, half, and πτερον, a wing, have their upper wings usually half crustaceous, and half membranaceous, not divided by a longitudinal future, but incumbent on each other, as the Cimex, fig. 2. (*t*) Blatta, *cockroach*. (*u*) Mantis, *camel-cricket*. Gryllus, *locust*. Fulgora, *cicada*, *flea-locust*. Cimex, *bug*. (*v*) Notonecta, *boat-fly*. Nepa, *water-scorpion*.

(*w*) Lepidoptera, from λεπις, a scale, and πτερον, a wing, are insects having four wings, covered with fine scales in the form of powder or meal, as in the butterfly, Papilio Antiopa, fig. 3. (*x*) Papilio, *butterfly*. (*y*) Phalaena, *moth*. (*z*) Sphinx, *hawk-moth*.

plants with tubular flowers. Insects of this species seldom sit to feed, but continue vibrating on the wing, while they thrust the tongue or proboscis into the flowers.

IV. Insects of this class (*a*) are found in woods (*b*), hedges, meadows, sand-banks, walls, pales, fruits, and umbelliferous flowers; some (*c*) fly about lakes and rivers in the day.

V. The fifth division (*d*) including wasps (*e*), bees, (*f*), &c. may be seen about hedges (*g*), shrubs, flowers, and fruits. Wasps and bees are the only winged insects that have any great degree of poison in them; they should therefore be taken with a pair of forceps, and handled cautiously on account of their stings, which are dangerous. Some (*h*) of this division have stings, but no poison, and are to be found on the flowers of umbelliferous plants, when the sun shines hot in the middle of the day; at which time others (*i*) are seen on sand-banks, walls, and pales.

VI. Flies of various kinds constitute the next class (*k*); they fly about the tops of trees (*l*),

(*a*) Neuroptera, from νεῦρον, a nerve, and πτερον, a wing, have four membraneous transparent naked wings, generally like network, as in the Panorpa Coa, fig. 4.

(*b*) Myrmeleon, hemerobius, *pearl-fly*. Raphidia, *camel-fly*. (*c*) Libellula, *dragon-fly*. Ephemera, *may-fly*. Phryganea, *spring-fly*.

(*d*) Hymenoptera, from ὑμὴν a membrane, and πτερον a wing. Insects with four membraneous wings, tail furnished with a sting; as in the Tenthredo, fig. 5. (*e*) Vespa, *wasp*. (*f*) Apis, *bee*. (*g*) Tenthredo, *saw-fly*. Sirex, *tailed-wasp*. Ichneumon, *ichneumon-fly*. Spheg, *ichneumon-wasp*. Vespa. Apis. (*h*) Mutilla, *naked-bee*. (*i*) Chrysis.

(*k*) Diptera, from δύο two, and πτερον, a wing, are such as have only two wings, and poisers, as in the fly, fig. 6.

(*l*) Oestrus, *gad-fly*. Musca, *fly*. Tabanus, *whame*. Hippobosca, *horse-fly*.

little hills, horses, cows, sheep, ditches, dung-hills, and every offensive object. Some (*m*) are found on all sorts of flowers, particularly those of a foetid smell. Many (*n*) of these are most easily taken when they begin to feed; for in the middle of the day they are so quick and active, that it is almost impossible to catch them.

VII. The last great division (*o*) contains scorpions, spiders, crabs, lobsters, &c. It is necessary only to observe here, that all kinds of insects having no wings may be preserved in spirits, brandy or rum, except crabs, lobsters, and the like, which may conveniently be preserved dry.

Under each class of insects, I shall relate the methods of killing them the most readily, and with the least pain, as the pursuit of this part of natural history hath often been branded with cruelty; and however reasonably the naturalist may exculpate himself by pleading the propriety of submitting to an evil, which leads to useful discoveries, yet for wanton cruelty there never can be a just pretext.

—The poor beetle that we tread upon,
In corp'ral sufferance finds a pang as great
As when a giant dies (*p*).

I. The first class, consisting of beetles (coleoptera) are hard-winged. Many kinds fly about in the day, others in the evening, some at night only. They may be caught with a gauze net,

(*m*) *Tipula*. *Conops*. *Afilus*, *wasp-fly*. (*n*) *Bombylius*, *flower-breeze*.

(*o*) *APTERA*, from *a*, without, and *πτερον* a wing, insects having no wings, as the spider, fig. 7.

(*p*) Shakespeare's *Measure for Measure*.

or a pair of forceps covered with gauze. When they are taken, stick a pin through the middle of one of the hard wings, and pass it through the body, as in plate, fig. 1. They may be killed instantly, by immersion in hot water, as well as in spirit of wine; then stick them on a piece of cork, and afterwards carefully place their legs in a creeping position, and let them continue exposed to the air until all the moisture is evaporated from their bodies. Beetles may also be preserved in spirit of wine, brandy, or rum, closely corked up.

II. Insects of the second class (hemiptera) may be killed in the same manner as beetles, and likewise by means of a drop of the ethereal oil of turpentine applied to the head; or in the manner to be described under the next class for killing moths.

III. The division of butterflies and moths (lepidoptera) as well as all flies with thin membranaceous wings, should be caught with a gauze net, or a pair of gauze forceps: when taken in the forceps, run a pin through the thorax or shoulders, between the fore-wings, as in plate, fig. 3. After this is done, take the pin by the head, and remove the forceps, and with the other hand pinch the breast of the insect, and it will immediately die: the wings of butterflies should be expanded, and kept so, by the pressure of small slips of paper, for a day or two. Moths expand their wings when at rest, and they will naturally take that position.

The larger kinds of these insects will not so readily expire by this method, as by sticking them upon the bottom of a cork exactly fitted to the mouth of a bottle, into which a little

fulphur had been put, and by gradually heating the bottle till an exhalation of the fulphur takes place, when the insect instantly dies, without injuring its colors or plumage.

The best method of having the most perfect butterflies, is to find out, if possible, the larva or caterpillar of each, by examining the plants, shrubs, or trees they usually feed upon, or by beating the shrubs and trees with long poles, and thereby shaking the caterpillars into a sheet spread underneath to receive them; to put them into boxes covered with thin canvas, gauze, or cat-gut, and to feed them with the fresh leaves of the tree or herb on which they are found; when they are full grown, they will go into the pupa, or chrysalis state, and require then no other care, till they come out perfect butterflies, at which time they may be killed, as before directed. Sometimes these insects may be found hanging to walls, pales, and branches of trees, in the chrysalis state.

Moths might likewise be procured more perfect, by collecting the caterpillars, and breeding them in the same manner as butterflies. As the larvæ or caterpillars cannot be preserved dry, nor very well kept in spirit, it would be satisfactory if exact drawings could be made of them while they are alive and perfect. It may be necessary to observe, that in breeding these kinds of insects, some earth should be put into the boxes, as likewise some rotten wood in the corners; because, when the caterpillars change into the pupa, or chrysalis state, some go into the earth, and continue under ground for many months before they come out into the moth state; and some cover themselves with a hard shell,

shell, made up of small pieces of rotten wood. Hence also, as many go into the earth, valuable insects may sometimes be found by digging after them a foot deep, about the roots of trees, shrubs, and plants.

IV. The fourth class of insects (neuroptera) may be killed with spirit of wine, oil of turpentine, or by the fumes of sulphur.

V. Those of the next class (hymenoptera) may be killed in the same manner. A pin may be run through one of their wing-shells and body, as represented in plate, fig. 5.

VI. Insects of the sixth class (diptera) may likewise be killed by spirit, or by fumes of sulphur.

VII. Those of the last division (aptera) are in general subjects which should be kept in spirit.

When in search of insects, we should have a box suitable to carry in the pocket, lined with cork at the bottom and top to stick them upon, until they are brought home. If this box be strongly impregnated with camphor, the insects soon become stupefied, and are thereby prevented from fluttering and injuring their plumage. Besides a gauze forceps, the collector should have a large musquito gauze net, made in the shape of a bat fowling-net, and also a pin-cushion with three or four different sizes of pins, to suit the different sizes of insects.

In hot climates, insects of every kind, but particularly the larger, are liable to be eaten by ants and other small insects, especially before they are perfectly dry: to avoid this, the piece of cork on which our insects are stuck in order to be dried, should be suspended from the ceiling of a room, by means of a slender string or thread;

thread; besmear this thread with bird-lime, or some adhesive substance, to intercept the rapacious vermin of these climes in their passage along the thread.

After our insects are properly dried, they may be placed in the cabinet or boxes where they are to remain: these boxes should be kept dry; and also made to shut very close, to prevent small insects from destroying them; the bottoms of the boxes should be covered with pitch, or green wax, over which paper may be laid; or, which is better, lined with cork, well impregnated with a solution of corrosive sublimate mercury, in a saturated solution of crude sal-ammoniac in water, an ounce of which will dissolve twenty scruples of the sublimate.

The finest collections have been ruined by small insects, and it is impossible to have our cabinets too secure. Such insects as are thus attacked may be fumigated with sulphur, in the manner described for killing moths; if this prove ineffectual, they may be immersed in spirit of wine, without much injuring their fine plumage or colors, and afterwards let them be sprinkled about their bodies and insertions of the wings with the solution above-mentioned. But baking the insects in an oven in the manner to be described in the next section for birds, is the most effectual method of extirpating these enemies; however the utmost caution is requisite in this process, in regulating the heat of the oven.

These observations and directions respecting insects, may, perhaps, be the means of exciting the curiosity of some, whose enquiries after this part of natural history will be amply compensated by the frequent opportunities of enlarging
their

their knowledge, as there is scarce any part of the surface of this globe, scarce a tree, a shrub, or a plant, an animal either living or dead, or even the excrements of animals, on which some kind of insect does not depend for its subsistence and propagation.

—————The flowery leaf
 Wants not its soft inhabitants. Secure,
 Within its winding citadel, the stone
 Holds multitudes. But chief the forest-boughs,
 That dance unnumber'd to the playful breeze,
 The downy orchard, and the melting pulp
 Of mellow fruit, the nameless nations feed
 Of evanescent insects. Where the pool
 Stands mantled o'er with green, invisible,
 Amid the floating verdure, millions stray.
 Each liquid too, whether it pierces, soothes,
 Inflames, refreshes, or exalts the taste,
 With various forms abounds. Nor is the stream
 Of purest crystal, nor the lucid air,
 Though one transparent vacancy it seems,
 Void of their unseen people———— (q).

(q) Thomson's Seasons, Summer, l. 296.

S E C T. II.

Method of preserving BIRDS and other Animals.

———Vitam excoluere per Artes.

VIR. Æn. 6. v. 663.

THE general increase of knowledge of late in natural history, from the attention of individuals to various branches of it, must afford no small degree of pleasure to the sensible part of mankind. Whilst such different researches have given entertainment to different dispositions, enlarged the mind, and engaged and diverted it from unprofitable or dangerous pursuits, they have occasionally given rise to the most useful improvements in every department of life, and afforded means of joining utility with elegance.

To promote these purposes more effectually, a more general knowledge of a good antiseptic for animal substances has been much enquired after. Owing to a want of this, many curious animals, and birds particularly, come to our hands in a very imperfect state: some from foreign parts entirely miscarry, and others of the finest plumage are devoured by insects.

Since the first insertion of this account in the Gentleman's Magazine (*r*), the methods used by the ingenious captain Davis, and T. S.

(*r*) Vol. IX. 1770, page 293.

Kuckahn, have been published in the Philosophical Transactions (*s*), of which I shall also avail myself, and add such notes, as will convey an idea to the reader wherein these methods may be improved, and rendered more simple and familiar.

The former directs birds in perfect plumage, “to be opened from the upper part of the breast to the vent, with a sharp knife or pair of scissars, the feathers of the breast and belly being first carefully laid aside by the fingers, so as not to hinder the skin being easily come at. The skin must then be carefully loosened from all the fleshy parts of the breast, body, thighs, and wings; after this, cut off all the flesh from those parts, and take out also the entrails and all the inside: then, having got a composition (*t*) of burnt alum, camphor, and cinnamon, of each an equal quantity, well powdered and mixt together, strew some of this powder lightly over the whole carcase; but salt is by no means to be used with this composition, as it always will drop and nasty the plumage in moist weather; pour also into the body a small quantity of camphor dissolved in rectified spirits of wine (*v*); after that, fill up the cavity with fine cotton, or any soft woolly substance, pouring some of the aforesaid spirits into the cotton or stuffing. Open next the mouth, and with a pair of scis-

(*s*) Vol. IX. anno 1770, page 184, and 302. From the specimens both these methods appear to succeed.

(*t*) For this composition I substitute Kuckahn's dry compound, altered in the manner hereafter to be mentioned.

(*v*) The application of spirit of wine and camphor, is always unnecessary in preserving these subjects.

“fars take away the tongue, the roof of the
 “mouth (*x*), eyes, brains (*y*), and inside of the
 “head (*z*); fill that also with the same com-
 “position; and having procured eyes as near
 “the natural ones as possible, put them into
 “the sockets by means of a small pair of nip-
 “pers introduced at the mouth. The eyes will
 “be best made by letting fall some drops of
 “black sealing wax on a card of the size of
 “the natural ones (*a*); the card must be cut
 “something larger than the wax, to prevent
 “their falling out of the head. Fill the head
 “quite full with cotton, pouring some of the
 “spirits down the throat, with some of the
 “powder; a small piece of brass wire, that has
 “been heated in the fire to make it pliable,
 “may be put down the throat, being passed
 “through one of the nostrils, and fastened to
 “the breast bone, to place the head in any atti-
 “tude you choose; next fill up the body, where
 “the flesh has been taken away, with cotton
 “and your composition; and having a fine

(*x*) To remove the roof of the mouth is both difficult and unnecessary.

(*y*) In large birds the brains may be extracted by the eyes; the best instrument for this purpose, is a director used by surgeons, which may be had of an instrument maker at a trifling expence.

(*z*) Kuckahn directs the neck to be pulled within the skin, till the back of the skull is drawn in sight, out of which a small piece is to be cut, and the brains extracted; the cavity of the skull is then to be moistened with the varnish, sprinkled with the powder, and filled up with cotton, &c. and then the skin may be drawn back to its proper place; but this is troublesome and injurious to the subject.

(*a*) Wax is not a proper substance for eyes; there are persons in London, whose business it is to make glass eyes of any size or color, at a penny or two pence a pair.

“needle

“ needle and filk, sew up the skin, beginning
 “ at the breast, observing, as you approach to-
 “ wards the vent, to stuff the skin as tight as it
 “ will bear. This will be easiest accomplished
 “ by means of a small piece of stick or ivory,
 “ like a skewer, till the whole is done: then lay
 “ your feathers of the breast and belly in their
 “ proper order, and your bird will be com-
 “ pleted. If you would chuse to put it into an
 “ attitude, by introducing a small piece of the
 “ wire above-mentioned through the sole of
 “ each foot up the leg, and into the pinion of
 “ each wing (*b*), it may be disposed of as you
 “ please.”

Instead of using the solution of camphor in spirit of wine, Kuckahn recommends a liquid varnish, made of two pounds of common or raw turpentine, one pound of camphor, and one pound of spirit of turpentine. The camphor is to be broke into very small pieces, and the whole is to be put into a glass vessel, open at top, which is to be placed in a sand heat, till the ingredients are perfectly dissolved (*c*).

For the dry compound of cinnamon, burnt alum, and camphor, directed in the foregoing

(*b*) Leman preserved the attitude of his birds by a wire run sideways through one wing into the breast bone, the other end of the wire being fastened into the box inclosing the bird; instead of fastening the ends of the wires to the pinions of the wings, after Captain Davis's method, I have always found it more convenient to fasten them to the breast bone; in either case this should be done before the bird is sewed up.

(*c*) This is a disagreeable daubing composition, and is besides unnecessary, as well as any other liquid application.

method,

method, he substitutes the two following compositions.

Corrosive sublimate,	—	—	$\frac{1}{4}$ lb.
Saltpetre prepared or burnt,	—		$\frac{1}{2}$ lb.
Alum burnt,	—	—	$\frac{1}{4}$ lb.
Flowers of sulphur,	—	—	$\frac{1}{2}$ lb.
Musk (<i>d</i>),	—	—	$\frac{1}{4}$ lb.
Black pepper,	—	—	1 lb.
Tobacco ground coarse.	—	—	1 lb.

Mix the whole together, and keep it in a glass vessel stopped close. Some of this is to be strewed upon the inside of the skin and cavity of the head, after they have been washed with the varnish.

The other dry composition (*e*) is made of equal quantities of tanfy, wormwood, hops, and tobacco, which are to be cut small and mixed together; with this the cavities of the craw and body are to be stuffed. He likewise directs an artificial breast to be made of soft wood, and

(*d*) The musk renders this composition very expensive, for which the same quantity of camphor might be substituted with real advantage; with this alteration, I make use of this powder, as cheaper than the composition recommended by Captain Davis, and equally effectual. Sir Car. a Linné recommends a composition of aloes, myrrh, and colocintida. And Kramer mentions arsenic and burnt alum.

(*e*) This is entirely useless, and forms a less soft and smooth stuffing than cotton or tow, which on that account are preferable. The reader will observe the difficulty and expence of following this complex method recommended by Kuckahn; it is indeed surprising that his prolix directions should be admitted at large into the Philosophical Transactions.

fitted

fitted to the proper place, after being moistened with the varnish (*f*).

In short, after opening the bird by a longitudinal incision from the breast to the vent, dissecting the fleshy parts from the bones, and removing the entrails, eyes, brains and tongue, the cavities and inside of the skin are to be sprinkled with the powder; the eyes are then to be inserted, and the head stuffed with cotton or tow; in the next place a wire is to be passed down the throat through one of the nostrils, and fixed into the breast bone; wires are also to be introduced through the feet, up the legs and thighs, and inserted into the same bone; next fill the body with cotton to its natural size, and sew the skin over it; the attitude is lastly to be attended to, and in whatever position the subject is placed to dry, that same will position will be retained afterwards (*g*).

When these antiseptic powders before mentioned cannot be had, tobacco sand mixed with a small proportion of alum, black pepper, and camphor, may be substituted.

Small birds may be preserved in brandy, rum, arrack, or first runnings; though in this manner the color of the plumage is liable to be extracted by the spirit.

Large sea-fowl have thick, strong skins, and such may be skinned; the tail, claws, head, and

(*f*) It is almost impossible to proportion an artificial breast exactly of the natural size and shape; cotton or tow answers every purpose with less trouble; the varnish I have before observed to be useless and inconvenient.

(*g*) The author's collection in natural history is always open for inspection, and any information in his power may be commanded.

feet are carefully to be preserved, and the plumage stained as little as possible with blood. The inside of the skin may be stuffed as recommended above.

Kuckahn observes that “ Baking is not only
 “ useful in fresh preservations, but will also be
 “ of very great service to old ones, destroy-
 “ ing the eggs of insects; and it should be a
 “ constant practice once in two or three years
 “ to bake them over again, and to have the
 “ cases fresh washed with camphorated spirit,
 “ or the sublimate solution, which would not
 “ only preserve collections from decay much
 “ longer, but also keep them sweet (*b*).”

One of the best preservatives, is to procure close boxes, well glazed: with such a precaution I have kept them in a dry room many years without the least appearance of injury.— Baking is apt to crimp and injure the plumage; unless great care be used, and therefore the proper degree of heat should be ascertained by means of a feather, before such subjects are baked.

When the subject is to be kept some time in a hot climate, it should be secured in a box filled with tow, oakum, or tobacco, well sprinkled with the sublimate solution (Sect. I. p. 10.) The same preparations and precautions already described, are equally applicable to quadrupeds in general.

Small quadrupeds, all kinds of reptiles, as snakes, lizards, and frogs; fish (*i*) of all sorts,
 and

(*b*) See Philosophical Transactions, vol. LX. page 319.

(*i*) Sir Car. à Linné describes another method of preserving fish; this is to expose them to the air, and when they

and small tortoises, with sea eggs (*k*), and sea stars, may be put into brandy, rum, arrack, or first runnings, with the addition of a little alum

Shells constitute an extensive part of natural history, and may be collected in great plenty and variety on the shores of most islands and continents. Those which are found with the fish in them, are the most valuable for the brightness of color, and smoothness of surface, as they lose that beauty and polish, when they have been long exposed to the sun. In bivalves, or those having double shells, as cockles, oysters, &c. both the shells should always be collected. It is sufficient in packing up shells, to prevent

they acquire such a degree of putrefaction, that the skin loses its cohesion to the body of the fish, it may be slid off almost like a glove; the two sides of this skin may then be dried upon paper like a plant, or one of the sides may be filled with plaster of Paris, to give the subject a due plumpness. Vid. Amæn. Acad. Vol. III. A fish may be prepared, after it has acquired this degree of putrefaction, by making a longitudinal incision on the belly, and carefully dissecting the fleshy parts from the skin, which are but slightly attached to it in consequence of the putrescency; the skin is then to be filled with cotton and the antiseptic powder as directed for birds, and lastly, to be sewed up where the incision was made.

After this method of preparation I have just received a fish from the West Indies; and the large collection in the Prince's cabinet at Brussels, there is reason to conclude was prepared in a similar manner.

(*k*) The echini, or sea eggs, may also be dried; but they are then so liable to be broken, that the safest method is to preserve them in spirit.

Horret capillis, ut marinus, asperis,
Echinus. HOR. Epod. V. 27.

their rubbing against each other, which may be effected by means of paper, moss, sand, &c. Some of the shell fish may be preserved in spirits, as this might prove an useful addition to the knowledge of this department of natural history.

The nests and eggs of birds, would likewise contribute to increase the knowledge of natural history, and prove also highly ornamental amongst collections in that branch of zoology.

S E C T.

S E C T. III.

*Directions for bringing over SEEDS and
PLANTS from distant Countries.*

Nor ev'ry plant on ev'ry soil will grow ;
 The fallow loves the watry ground, and low ;
 The marshes, alders : Nature seems t' ordain
 The rocky clift for the wild ash's reign ;
 The baleful yeugh to northern blasts assigns ;
 To shores the myrtles ; and to mounts the vines (l).

EVERY part of the world has its peculiar productions ; and in no objects of natural history is the variety more entertaining, than in the vegetable kingdom. The gardens of the curious have already been enriched with many valuable acquisitions from distant countries ; but many attempts also to introduce several other plants equally rare, have been unsuccessfully made, owing to the bad state of the seeds or plants when first procured, or the method of disposing of them during long voyages, and such accidents as the utmost precaution cannot prevent. The ingenious J. Ellis, F. R. S. has favoured the world with the most judicious observations on the present subject, which may

(l) Nec vero terræ ferre omnes omnia possunt.
 Fluminibus salices, crassisque paludibus alni
 Nascuntur, steriles saxosis montibus orni.
 Littora myrtetis lætissima : denique apertos
 Bacchus amat colles ; aquilonem et frigora taxi.
 VIRG. G. II. 109.

soon prove the means of many useful additions in horticulture to this kingdom ; where

Beds of all various herbs, for ever green,
In beauteous order terminate the scene (*m*).

Ripe feeds should be chosen for this purpose, which have been collected in dry weather, and kept dry without exposing them to sunshine ; and internally they should be plump, white, and moist.

a. They may be preserved by rolling each in a coat of yellow bees wax, about half an inch thick ; and afterwards a number of these thus prepared, may be put into a chip box, which is to be filled with melted bees wax, not made too hot : the outside of the box may then be washed with the sublimed solution, (Sect. I. page 10.) and kept during the passage in a cool airy place. In this manner tea seeds, the stones of mangoes, and all hard nuts and leguminous seeds in general, may be prepared.

b. Instead of putting small feeds in bees wax, they may be inclosed in paper or cotton which has been first steeped in melted bees wax, and then placed in layers in a chip box, which is to be filled as before with melted bees wax. Pulpy feeds, as those of strawberries, mulberries, arbutuses, &c. may be squeezed together and dried, and then put into the cerate paper or cotton above-mentioned.

c. The small feeds well dried may be mixed with dry sand, put into the cerate paper or cotton, and packed in glass bottles, which are to be well corked and covered with a bladder or leather. These bottles may be put into a keg, box, or any other vessel, filled with four parts

(*m*) Pope's Homer's Odyss. 7.

of

of common salt, two of saltpetre, and one part of sal armoniac, in order to keep the seeds cool, and preserve their vegetative power (n).

The following methods, which are attended with less trouble, have been also found successful.

- d. Seeds and nuts in their pods, may be enclosed in linen or writing paper, and put into canisters, earthen jars, snuff boxes or glass bottles; the interstices between the parcels of seeds should be filled with whole rice, millet, panic, wheat bran, or ground Indian corn well dried. To prevent any injury from insects, a little camphor, sulphur or tobacco should be put into the top of each canister or vessel, and their covers well secured, to exclude the admission of the external air.
- e. The seeds well dried may be put into a box, not made too close, upon alternate layers of moss, in such a manner as to admit the seeds to vegetate, or shoot their small tendrils into the moss. In the voyage, the box may be hung up at the roof of the cabin; and when the ship is arrived at the place of her destination, the seeds should be put into pots of mold, with a little of the moss also about them, on which they had lain.

Seeds preserved after this manner, and also in the preceding (d), which are procured in the

(n) A method of preserving seeds similar to this, was first proposed by the celebrated Linnæus, which he thus relates in a letter I had the honor of receiving from him. "*Lagenula vitrea repleatur seminibus in Indiis nuper lectis et ficcioribus, dein subere optime claudatur. Hæc indetur Lagenæ multo capaciori, et repleatur salibus variis mixtis, ita ut sale undique lateribus, scilicet, fundo et orificio incarcetur interio Lagenula. Salibus mixtis oritur frigus majus, ne a calore climatis exsiccentur semina.*"

East Indies, may be examined when the ship arrives at St. Helena; and some of them which appear in a state of vegetation, should be sown in cases or tubs of earth kept as secure as possible from sea water; some holes should be cut in these cases or tubs, and covered with bast-mats or sail-cloth, which will admit sufficient air.

More of the same seeds may be also sown after the ship has passed the tropic of Cancer, near the latitude of thirty degrees north. Plants or shrubs that are to be transported, must be taken out of the ground with a quantity of the soil covering the roots, which should be wrapped in wet moss, and surrounded with a bast-mat, or dry plantain leaves, and put into the cases or tubs, with the precautions above-mentioned.

In whatever method our seeds have been preserved, it should be a constant precaution to sow them as soon as they have been exposed to the external air, otherwise they probably will never vegetate.

In the first edition of this work, plaster of Paris was recommended, as a proper substance for preserving seeds in a state of vegetation; this was tried upon acorns by the ingenious naturalist already referred to, and kept for three months (from January 11. to April 2. 1772.) When these acorns were examined, they were found dry, and as hard as horn. This substance therefore, as well as clay, is very improper for preserving seeds, &c. as it absorbs their moisture, and thereby destroys their vegetative power (o).

(o) See also Philosophical Transactions, Vol. 51. part 1. page 206.

When the naturalist is in search of vegetable productions, different soils and situations should be examined; as the sea, and its shores, deep running waters, dikes, marshes, moors, mountains, cultivated and barren fields, woods, rocks, &c. afford each their peculiar plants; and wherever any are collected, the particular soil and situation should be remarked.

From the moist meadow to the wither'd hill,
Led by the breeze, the vivid verdure runs,
And swells, and deepens, to the cherish'd eye (*p*).

Sometimes it may prove inconvenient to convey the plants which may be discovered, when it would not be so to send them dried in the form of a hortus-ficcus. To do this in the best manner, and to make their stalks, leaves, &c. lie flat and smooth, they must be exposed betwixt papers to a free dry air, with considerable pressure upon them. The leaves and flowers should be carefully expanded, for on this the beauty and value of the specimen greatly depends. Those plants should also be gathered on a dry day, while they are in full bloom, and all their parts perfect and entire. When perfectly dry, they may be kept either loose in quires of paper, or fastened into a book, with glew made of fine isinglass dissolved in boiling water. Particular care is to be taken to avoid any injuries from moisture, or insects; to prevent any accident from the latter, let the paper and stalks of the plants be sprinkled with the sublimate solution, (Sect I. p. 10.)

The impressions of plants well taken off upon paper, look very little inferior to the best draw-

(*p*) Thomson's Seasons, Spring, l. 86.

ings,

ings, and may be done with very little trouble. For this purpose, some printer's ink (*q*), and a pair of printer's bosses, such as are used for laying the ink on types, are necessary. After rubbing these bosses with a little of the ink, lay the plant betwixt them, and press it so as to give it sufficient color; then take the plant and lay it carefully on a sheet of paper, and press it with the hand, to give the impression of the plant to the paper, which may be afterwards colored according to nature; a piece of blotting paper may be placed betwixt the plant and the hand, to prevent the latter from being dirtied by the ink.

But the most effectual method of sending a branch of any plant with the flowers and parts of fructification entire and perfect, is to put them in bottles of brandy, rum, or arrack.

Corals, corallines, sponges, &c. inhabitants of the sea, are found in considerable variety near the coasts of islands and continents, particularly in hot climates. Some of these are very tender and brittle when dry, and should therefore be carefully packed up in sand, in order to keep them steady, or placed betwixt papers in the manner of an *hortus-ficcus*.

In hot climates, the insects are very rapacious (*r*); and I have seen the finest fan-corals, and others of a soft texture when first taken out

(*q*) Where this cannot be procured, ivory, or lamp black, ground with boiled linseed oil, may be substituted.

(*r*) It has been related, that the Spaniards after having settled on the north side of Jamaica, were obliged to quit it, on account of the rapaciousness of the ants, which are said to have killed their children by eating their eyes, when they were left in their cradles.—Sloane's nat. hist. of Jamaica, vol. I. introd. p. 48. et passim.

of the sea, almost devoured by ants, before they became dry and hard. To prevent injuries of this kind, a little powdered corrosive sublimate, or the sublimate solution (Sect. I. page 10.) may be sprinkled upon these productions. Some of the small, and branches of the large ones, might also be put into spirits, and the parts of them thereby preserved much more distinct, which would serve greatly to illustrate their natural history (s).

(s) Though the author agrees with the ingenious J. Ellis, F. R. S. in the propriety of ranking corals, corallines, &c. among the animal kingdom, he has placed them under this section, as they are usually thought to be vegetable productions, and in their external appearance certainly resemble them.

S E C T.

S E C T. IV.

Method of analyzing M E D I C I N A L
W A T E R S (*t*).

Qui autem ad observandum adjicit animum, ei etiam,
in rebus quæ vulgares videntur, multa observatu
digna occurrunt.

BACON de Augment. Scient.

AS many springs contain a volatile principle, soon liable to be dissipated, it is necessary to make our experiments on the spot, in order to discover the contents of such waters. Various as these contents may at first appear, the apparatus proper to detect all of them may be reduced into a very small compass.

When we purpose to examine any medicinal spring, the soil and face of the country should be considered, the stony or mineral appearance, and particularly whether there are any mineral veins; the degree of heat of the water should be ascertained by a thermometer, and its comparative weight to other springs in the neighbourhood also carefully observed; after which we may enter on our experiments.

(*t*) Wallerius in his Hydrologia, Lewis in his notes on Neumann's chemistry, with Rutty, Lucas, Falconer, Monro, and other writers, have given directions upon this subject; but my friend Dr. Walker of Hull has treated it professedly in his elegant Thesis de Aqua Sulphurea Harrowgatensi, Edinb. 1770, dedicated to that learned Chemist and Philosopher Dr. Black.

I. AERIAL MATTERS.

1. MEPHITIC, FIXABLE, OR FIXED *air*, is heavier than common, or vital air, and frequently mixed with water; by which union, common water is capable of dissolving iron, and thereby forming a chalybeate spring, as in Pyrmont, Spa, and many other celebrated mineral waters (*v*).

This mephitic air is detected by lime-water, the former precipitating the calcareous earth of the latter in a white powder. To discover the quantity of this aerial matter, a bottle filled with the mineral water should be tied over the mouth with a loose bladder: the bottle is then to be placed in boiling water, the heat whereof will extricate the mephitic air, which rising into the bladder, may be collected by tying the bladder close to the neck of the bottle, and afterwards measured by a proportionable bulk of water. (See Sect. V.)

II. SALINE BODIES.

1. An ACID is sometimes found in the composition of mineral waters, which is always the vitriolic.

a. In its fixed state, which is supposed to be separated from pyrites: this is however very rare, and probably never occurs, as it cannot remain long in this state, without being neutralized by earths, salts, or metals.

(*v*) This was noticed many years ago by Dr. Black in his lectures, and has since been adopted by several ingenious writers.

Many

Many of those springs called acidulæ, received this name from the mephitic air we have already mentioned. If this acid be present, it may be discovered by an infusion of syrup of violets, or by an infusion of lacmus, or archil (*w*), which are turned of a brighter or reddish color by it. This acid may be detected also by a solution of lead in the nitrous acid; the solution should be fully saturated. The nitrous acid uniting with calcareous earth, or fossil alkali, falls in a white sediment, while the vitriolic acid combines with the lead.

b. In its volatile sulphureous state. (See page 32.)

2. An ALKALI is also very seldom found in water in its proper state.

a. When a *fossil alkali* is present, it is more nicely detected by the syrup of violets, or infusion of lacmus, than the former, these being turned green by the least portion of alkali. If a considerable quantity of alkali were combined with the water, it might be precipitated by a solution of calcareous earth, or by acids.

b. A *volatile alkali* may be distinguished by a solution of corrosive sublimate mercury in water, or in the nitrous acid, the alkali rendering the solution white, a precipitation of a white powder ensues; but no change is produced, when the alkali is the fixed or fossil, or if any, the mercury will be precipitated in an orange, brown,

(*w*) This is so nice a test, that even mephitic air is apt to give it rather a brighter color.

Since the first edition, Dr. Priestley makes a similar observation on the authority of his correspondent M. Bregman of Upsal. Philosophical Transactions, Vol. LXII. 1773.

or

or reddish powder; where there is a considerable quantity of the volatile alkali, the water turns blue by the addition of copper. When this alkali is in a very small proportion, some of the water should be distilled over.

3. NEUTRAL SALTS are frequently found in medicinal waters.

- a. GLAUBER'S SALT, compounded of vitriolic acid, and fixed fossil alkali; spirit of wine added to a solution of this salt, precipitates it in a white powder; but no change is produced by the addition of any alkaline salt.
- b. EPSOM SALT, formed of the same acid, and the earth of magnesia, is often a composition in purging waters. Any alkaline salt, either fixed or volatile, turns this water milky or curdly; the alkaline salt uniting with the vitriolic acid, precipitates the earth of magnesia.
- c. NITRE, is composed of the nitrous acid, and fixed alkali. Water containing this salt should be evaporated, and the nitre remaining may be known by deflagration, or by its making a crackling noise over the fire. When the nitrous acid is combined with calcareous earth instead of the fixed alkali, the earth may be precipitated by the addition of this alkali.
- d. COMMON SALT, consisting of the muriatic acid, and fossil alkaline salt. The acid of this salt is nicely detected by a solution of silver in the nitrous acid; the muriatic acid, having a nearer affinity with silver than the nitrous, unites with the silver, which falls down in a white sediment, while the nitrous acid joins with the alkali of the common salt. It is proper to have a redundancy of the nitrous acid in the solution
of

of silver, lest the silver be precipitated by a calcareous earth, which may be in the water.

III. EARTHY SUBSTANCES.

- a. CALCAREOUS EARTH, or calcined LIME-STONE, is found in most wells and medicinal springs; the presence of which is best discovered by a solution of lead in the nitrous acid. This acid should be saturated with as much lead as it will dissolve, lest the superfluous acid should saturate the earth, and prevent the precipitation of the lead. If there be any calcareous earth in the water, this solution turns it milky, and after some time a white powder is deposited, the calcareous earth precipitating the lead, by uniting with the nitrous acid.
- b. If calcareous earth be suspended in water by combination with the vitriolic acid, gypsum, or selenites, is formed, which may be discovered by the addition of alkaline salt to this compound; the mixture should be warmed a little, to promote the precipitation of the selenitic earth.
- c. The same acid united with argillaceous earth, or earth of alum, produces an aluminous austere composition; and the earth may be precipitated also by alkaline salt, which uniting with the vitriolic acid, allows the earth to fall down in a sediment.

IV. SULPHUREOUS.

SULPHUR may be suspended in its proper form, though it is not soluble in this state; but when the principle of inflammability in sulphur
is

is combined with calcareous earth, or any alkali, in the form of an *hepar sulphuris*, it readily dissolves; in which case the water smells disagreeably, like the scourgings of a gun, or putrid eggs. It is distinguished also by a solution of *saccharum saturni* (sugar of lead) in the nitrous or vegetable acids; a little of this solution being marked in lines on paper, and the paper suspended over the water, the volatile sulphureous fumes arising from the water turn these lines of a brown or dark color; the inflammable matter of the sulphur uniting with the lead in the solution of the *saccharum saturni*, partly revives the metal, and hence produces that dark color. (See Sect. V. page 39, 40.)

V. BITUMINOUS BODIES.

BITUMEN frequently runs from amongst rocks, whence it is called *petroleum*; it is also common in the bowels of the earth, as hath been often fatally experienced from those bituminous vapours called 'fire-damps, which prove inflammable, and therefore differ from mephitic air, the latter extinguishing fire. Whether this inflammable vapour is formed of the principle of inflammability of sulphur and the vitriolic acid in a volatile state, is not so well ascertained as the remarkable effects produced by these bituminous bodies in the mountains of *Ætna*, *Vesuvius*, and many others mentioned in history.

LIQUID BITUMEN, NAPHTHA, OR PETROLEUM, is never found combined with water, but floats on its surface in a manner evident to the eye, and may be particularly distinguished by the taste and smell.

should be evaporated, and the residuum may be placed on a hot bar of iron, and if there be any arsenic, it is known by emitting a strong garlick-like smell; or this residuum may be moistened with oil, and put between two bright plates of copper, which, when heated, are turned of a white color, if any arsenic be present; but the smell generally affords a sufficient test.

S E C T. V.

Experiments on the CONTENTS *of the*
A I R.

C'est une erreur de croire, q'une experience aveugle, et une habitude mechanique, tiennent lieu de principes surs, et de maximes fondées sur un solide raisonnement.

BEECARIA Traduct. d'un discours sur la Commerce.

NOTHING is more evident than that our atmosphere abounds with a great variety of substances, if we consider the various exhalations constantly emitted from all vegetables; in prodigious quantities from all animal bodies; and the great variety of fossil matters that are incessantly rising in the atmosphere (y).

To investigate the nature of all these is impossible; in very few cases can we find the exhalation of one kind only; and many of them are of little consequence; for if we consider the quantity that is constantly exhaling, and the powers many of them might have in acting upon the human body, we should expect the effects to appear every moment to a considerable degree, which we find very far from being the case: there are certainly some means by which they are obviated: these exhalations are no doubt more or less diffused into the higher regions of the air;

(y) This was published before the author became acquainted with the observations on different kinds of air by the learned Dr. Priestley, and as this inquisitive philosopher is still pursuing his enquiries, it is thought sufficient to refer the reader to the original experiments, in the last volume of the Philosophical Transactions.

and

and probably also, from their mixture with one another, the most active come to be neutral and innocent.—

Did not the acid vigor of the mine,
Roll'd from so many thundring chimnies, tame
The putrid steams that overwarm the sky;
This caustic venom would perhaps corrode
Those tender cells that draw the vital air,
In vein with all their unctuous rills bedew'd *.

It is in few instances that the exhalations are not exposed to the means of mixture; and it is but seldom, comparatively, that effects are produced upon human bodies, although in a particular manner immersed in this vitiated atmosphere.

There are, however, some impregnations in the atmosphere, which daily experience shews have considerable influence on our bodies; for though they may not sensibly affect the more robust and strong, they certainly do the weak and delicate. With a view to investigate them more particularly, the following experiments were made in the beginning of August, in the year 1769.

For some preceding weeks the air had been generally warm and dry, and mostly free from wind; the evening on which I began to condense the atmospherical moisture was calm, and clos'd a fine warm day; the place where this moisture was collected, was in a court about the centre of Gracechurch-street.

I procured a large glass globe perfectly clean on the outside, into which I put a quantity of ice

* Armstrong's Art of preserving Health, p. 51.

and fal ammoniac powdered; the globe thus prepared; was suspended in the air about five yards from the surface of the ground; the cold produced by the ice and neutral salt congealed the moisture of the air on the external surface of the globe in the form of ice. This condensed body was carefully scraped off with a silver spatula, and received into a wide-mouthed bottle well rinsed: when I had collected in this manner some ounces of condensed matter, I proceeded on the following experiments.

E X P E R I M E N T I.

To know if it contained any fixed air, I put one ounce of the condensed moisture into a vial, the cork of which was perforated through the whole length, to admit the extricated air to pass through: over the cork was tied a loose bladder free from any air; I then placed the vial, thus prepared, in boiling water; the heat of the water extricating the fixed air from the condensed moisture, it escaped through the perforation of the cork into the bladder, where it was collected; the quantity of this air occupied a space, which of simple distilled water was equal in bulk to $1 \frac{1}{2}$ drachm. The vial, upon weighing it after the separation of the air, was reduced a few grains lighter.

To be more certain that a great part of this extricated air was fixed, I applied it to lime-water; a precipitation of calcareous earth ensued, which convinced me of its presence. (See Sect. IV. page 29.)

E X P E-

E X P E R I M E N T II.

I took a quantity of the condensed atmospheric moisture, which had not been exposed to heat; with this I mixed some syrup of violets diluted; the syrup evidently became of a greener color; which persuaded me that no acid, but an alkali, predominated. (See Sect. IV. page 30.)

E X P E R I M E N T III.

By mixing the condensed moisture with a solution of corrosive sublimate mercury, the mixture became of a pale white, which proved the alkali to be volatile; for with a fixed alkali no change could have been produced; or, if any, the mercury would have been precipitated in a brown or reddish powder, called *mercurius precipitatus fuscus Wortzii*. (See Sect. IV. page 30.)

E X P E R I M E N T IV.

A PIECE of paper marked with a solution of lead in distilled vinegar, was suspended over a quantity of the condensed moisture, while in a state of evaporation; but no change taking place in the lines marked on the paper, I concluded no sulphur or inflammable matter was detached. (See Sect. IV. page 32.)

E X P E R I M E N T V.

THE condensed moisture evaporated to dryness, yielded a brownish saline body, which from

some experiments (see Sect. IV. and VI.) appeared to be chiefly a compound salt of the vitriolic acid and volatile alkali, forming *sal vitriolatum ammoniacum*; this I procured in the proportion of about $1 \frac{1}{2}$ grain, in two ounces of the moisture.

From what appears to be the contents of the city air, as above related, many particulars result, which may afford some insight into the nature and cause of the different diseases in the city from those without. There is reason to presume, that putrid effluvia are noxious to animal bodies; they may very often introduce a ferment into a subject disposed to the putrefactive fermentation, and hence have a tendency to promote diseases which arise from a putrid diathesis.

But in populous cities, where prodigious quantities of these effluvia are daily generated, one might suspect very fatal effects, fevers of the most dangerous kinds, more frequently to occur. It may be here suggested from the foregoing experiments, that a vitriolic acid is detached from the coals burnt in this city, which uniting with the volatile alkali from putrid matters, may form a compound in no respect injurious to the human machine.

There appears from Experiment I. a material circumstance, which, until very lately, we were unacquainted with; we find that from all fermenting vegetables a fixed air is detached, which has sometimes proved a sudden poison to animals. The same air is generated from various sources, being exhaled from the earth, as well as rises from all breathing animals; and though a certain proportion of it when diffused
in

in the common or vital air seems conducive to health, yet when it becomes accumulated beyond this salutary proportion, it may injure what it was designed to preserve (z); from which reflection the poet judiciously resolves,

—————Now from the town
Buried in smoke, and sleep, and noisome damp,
Oft let me wander o'er the dewy fields,
Where freshness breathes, and dash the trembling
 drops
From the bent bush, as through the verdant maze
Of sweet-briar hedges I pursue my walk;
Or taste the smell of dairy; or ascend
Some eminence,—————
And see the country, far diffus'd around,
One boundless blush, one white-empurpled shower
Of mingled blossoms; where the raptur'd eye
Hurries from joy to joy————— (a).

Hence purer spirits through the blood diffus'd,
Give to the lip its ruby-tinctured hue:
Hence Health's gay smile illumines the dimpling
 cheek;
And the pulse lightly dances, as the breast
Inhales, slow-heav'd, the pure refreshing air (b).

(z) Upon this subject consult Hales, Macbride, Pringle, Percival, Alexander, Cavendish, Lane, and particularly Priestley's ingenious experiments and observations on different kinds of air, first published in the Philosophical Transactions in 1773. Vol. LXII. and since in a distinct treatise.

(a) Thomson's Seasons, Spring, l. 100.

(b) Ogilvie's Providence, l. 523.

S E C T. VI.

Directions for collecting and distinguishing Fossil Substances, including Earths, Stones, Salts, Inflammables, and Metals.

TO write particularly upon these objects of natural history, is not the present design : a few general instructions may be sufficient to direct a traveller in the choice of such fossil bodies as he may meet with. Wallerius, Woodward, Cronstadt, Linnæus, Da Costa, and Berkenhout, may supply an inquisitive enquirer with more extensive information.

Many are discouraged from pursuing this part of natural history, owing to the great variety of objects it comprehends, and the numerous properties by which they are distinguished. But these when attended to, appear much less complicated, and capable of being reduced to a few simple heads ; simple in their nature, and uniform in their composition ; all new combinations producing chiefly a change only in form, color, and consistence.

I. EARTHS and STONES in general.

Insipid, not inflammable, preserving their constitution in a strong heat, and such as are capable of fusion become glass ; the latter not soluble in pure water or oil.

A. EARTHS are bodies of no regular structure, or determinate figure, insipid, opaque, diffusible,
 I but

but not soluble in pure water, ductile while moist, not inflammable.

- a. There are several kinds of molds which are principally distinguished by their colors. Common mold, covers generally the surface of the globe; does not effervesce with acids, nor is it convertible into quicklime.
- b. Clays, mixed with a quantity of water, form a ductile paste; in the fire they harden.

These are various in their consistence and color, owing to their mixture with other bodies. Some, containing calcareous substances, effervesce with acids, which they do not when pure; and their variety in color is owing to the addition of iron, or other minerals. They are distinguished into porcelain clay, potter's or pipe-clay, common clay, boles, ochres, fuller's earth, tripela or rotten stone, loam, &c.

- c. Chalks and marles are frequently calcareous and effervesce with acids; whence they have been classed under calcareous stones; but as their consistence is different, and their effects with acids various, they are here placed under the division of earths (c).

B. CALCAREOUS STONES effervesce with, and are dissolved by acids; convertible into quicklime by burning; and do not strike fire with steel.

- a. They appear under many different forms, and are found in strata in the bowels of the earth, and frequently in large beds, as limestone, marble, &c.
- b. Some stones, which in their structure, appearance, and chemical properties resemble

(c) Vide Da Costa's Natural History of Fossils, page 6, and 75.

marble,

marble, may be included here, though they never form continued strata, being found only in loose independent masses, as the marmoroidæ, containing shells, corals, and other extraneous bodies, astroites or star stones, sea stars, entrochus, belemnites, cornu ammonis, or snake stone, &c. the remains of animals, which are consequently of a calcareous nature (*d*).

c. Spars are calcareous bodies, found in mines, attendant on ores, &c. when pure, of a glassy appearance, and often crystallised into polygonal figures, as common spar, refracting spar, crystallized spar, stalactites, isicle or dropstone.

C. GYPSUM or GYPS; a calcareous substance, saturated with the vitriolic acid, and hence does not effervesce with acids; falls into a white powder when heated, and concretes again with water into a mass, which soon hardens, called plaster or stucco, as plaster-stone, alabaster, fibrous plaster-stone or fibrous talc, gypseous powder, selenites, &c.

D. TALCS do not strike fire with steel, nor effervesce with acids; insoluble in water, and very refractory in the fire *per se*, but fusible with borax.

b. Micæ, glimmers or daze, have a scaly texture, the plates mostly running horizontally parallel, easily separable, of various colors, as

(*d*) The author does not attempt to give a complete system of fossils, but to comprize in as short and as simple a view as possible the principal heads they comprehend, and he conceives these bodies may not improperly stand as above, without introducing separate divisions of petrifications and incrustations, the stony substances suspended by the water being deposited upon mosses, roots, and branches of plants forming the latter.

green, grey, red, brown, black, gold colored, silver mica, &c.

c. ASBESTOS and AMIANTHUS, are bodies very refractory in the fire. The former is the most flexible, and may be wove with the addition of hemp or lint into cloth, capable of enduring violent heat; the lint is indeed consumed, but the asbestos remains unchanged. Formerly dead bodies were wrapped in this kind of cloth, when they were thrown upon funeral piles, to prevent the ashes of the deceased from mixing with the common ashes.

E. STONE, a concreted granulated substance; breaking freely in any direction; effects with fire and acids various.

a. Of these there are divers kinds, as the quartzose sand stone, free stone, Portland stone, Purbeck stone, Ketton stone, purple stone, Bath stone, &c.

b. Granite, vitrifiable, composed chiefly of quartz, mica, and felt spat (*e*), sometimes of garnet, basalt and indurated steatites; so hard as to strike fire with steel, and to receive a polish.

c. Conglutinated stones, composed of pebbles of various kinds, irregularly disposed, and cemented by different substances, as pudding stone, mill stone, &c.

c. Porphyry, has a fine compact uniform texture like flint, in which detached pieces or separate concretions of quartz are imbedded in all directions; strikes fire with steel, is fusible, but does not effervesce with acids, as ophites, serpentine stone, and porphyries of different colors.

(*e*) Called by Da Costa Rhombic Quartz.

F. SLATE breaks invariably into laminæ or plates; opaque, not flexible; in general does not strike fire with steel, though some of the red slates do; when written upon, the characters mostly white; effects with acids and with fire, various.

There are many kinds of slate, as the black, green, purple, blue, red, brown, grey, shale bas or shiver, plate slate, Irish slate, &c.

G. FLUOR, is of a sparry or crystalline appearance, does not strike fire with steel, or effervesce with acids, vitrescent *per se*; the most refractory is easily fusible with borax or calcareous earths; being gradually heated it shines like phosphorus, but its light vanishes before it becomes red hot; as the crystallized fluor, irregular fluor, cubic fluor, and zeolites.

H. SHIRL, cockle or basalt, is a heavy hard stone; shoots into crystals of a prismatical figure, mostly of a black or green color.

I. QUARTZ, strikes fire with steel, but does not effervesce with acids, nor fall to powder after burning. When pure cannot be melted *per se*, but with alkaline salts most readily into glass; texture solid, uniform; particles homogeneous, invisible, impalpable, as,

a. Pure quartz, rock crystal, or quartz crystal, smoaky topaz, amethyst, &c.

b. Crystals are diaphanous, hexagonal, columnar, pyramidal; some colorless, others milky, yellow, brown, red, purple or black; as cornish diamonds, Bristol stones, &c.

c. Flints, are semipellucid and detached; break in convex and concave polished fragments, as the common flint, opal, onyx, Scotch pebble, carnelian, mocha-stone, chalcedony or white agate,

agate, sardonyx, agate, cats-eye, &c. all of which decay by exposure to air.

d. Jasper is less hard than flint, and melts more readily into glass, but does not decay in the air. It is of a crystal basis of various colors, and always opaque, as the heliotrope, the green, red, yellow, black jasper, &c.

K. GEMS are crystals of various colors, generally found in small bodies, hard, bright and radiant, as the diamond, ruby, sapphire, topaz, beryl or bluish green topaz, chrysolite or yellowish green topaz, emerald, garnet. From the difficulty of procuring these bodies, few experiments have hitherto been made upon them; the experiments on diamonds by Dr. Darcet, prove them to be volatile by heat.

II. S A L T S.

S A L T S are soluble in water, and recoverable by evaporation to their pristine angular form; not inflammable nor ductile.

1. The simple salts are either alkaline or acid (*f*).

A. ALKALINE SALTS turn the syrup of violets, or an infusion of purple flowers, of a green color, and effervesce with acid salts.

a. Fossil alkali, so called from its being found in the earth, in large strata, but in a compound state. It is also in sea salt, and may be pro-

(*f*) Some of these salts are not native productions; but as an acquaintance with these substances may prove an introduction to the knowledge of many useful chemical facts, a more general account is here given of them.

cured

cured from the ashes of sea weeds by burning. This salt is the *natrum* of the ancients.

b. Vegetable alkali, procured chiefly from the ashes of land vegetables, whence are produced pearl ashes, pot ashes, &c.

c. Volatile alkali is distinguished from the other two by its volatility, as it evaporates by heat before it becomes fluid. It is procured from putrid substances, particularly animal, and also from some subterraneous fires, the urine of animals, all horny and bony substances, and plentifully from foot.

B. MINERAL ACID SALTS turn the syrup of violets, or an infusion of purple flowers, of a red color; they effervesce with alkaline salts, and are only obtained in a fluid state.

a. Vitriolic acid, or oil of vitriol, so called from vitriol or copperas, which contains this acid united with iron; is heavier than water, and colorless when pure. With the principle of inflammability it forms sulphur, from whence this acid is chiefly procured.

b. Nitrous acid, or aqua fortis, is of an orange tawney color. Exposed to the air, it emits fumes of a fiery color.

c. Muriatic acid, or spirit of sea salt, is a colorless transparent fluid. Exposed to the air, its fumes are white.

d. Acid of spar, is separated from the fluor (Cronstadt's Mineralogy, p. 109.) This newly discovered acid united with calcareous earth, forms the sparry fluor, from whence it may be disengaged by oil of vitriol, and the other mineral acids, which have a stronger affinity with calcareous earth. In smell and color the acid of spar resembles the muriatic acid, but with calcareous

calcareous earth, its common basis, it forms a solid substance; whereas the muriatic acid, combined with the earth, remains fluid. Vide Forster's translation of Scheele's experiments.

C. Besides these, we may enumerate,

a. Vinegar, or the acetous acid, which has the general properties of acid salts.

b. Tartar is a dry saline substance, neither fusible nor volatile; suffers no change from heat under the boiling point, or 212° . It does not readily dissolve in water, nor does it affect the syrup of violets so much as the preceding acids.

c. Sedative salt has the properties of salts in general. We are in great measure ignorant of its origin. It is chiefly procured from borax, a substance that is brought from the East Indies. Sedative salt is generally got in a crystallized form, resembling snow, or bruised sperma ceti.

2. NEUTRAL SALTS, or such as consist of an acid united with an alkaline salt, having the properties of salts in general. There are eighteen of these salts, which are enumerated in the following table, for which I am indebted to the learned Dr. Black of Edinburgh.

	Vitriolic acid.	Nitrous acid.	Muriatic acid.	Vinegar.	Tartar.	Sedative salt.
Fossil alkali.	Glauber's salt.	Cubic nitre.	Common salt.		Rochelle salt.	Borax.
Vegetable alkali.	Vitriolated tartar.	Nitre.	Digestive salt.	Regenerated tartar.	Tartarified tartar.	
Volatile alkali.	Vitriolated ammoniac.	Nitrous ammoniac.	Sal ammoniac.	Vegetable ammoniac.		

In the foregoing table the acids and alkalies point respectively to the salts which they compose. Thus the nitrous compound salts are placed in the second column, under the nitrous acid; and on the left side the particular alkali, with which each compound salt is combined, and so on of all the others.

These neutral or compound salts may be decomposed by the addition of an acid or alkaline salt; and their attractions are in proportion to the order set down in the table: thus if we want to separate a volatile alkali from an acid, either of the fixed alkalies will answer. There is no line drawn between the fossil and vegetable alkalies, because their powers of attraction are nearly the same. The acid salts are likewise placed in the same order of attraction; the first column, or vitriolic acid, separates the second or nitrous acid; and this the third or muriatic acid, and so on of all the rest.

3. METALLIC COMPOUND SALTS, metal dissolved in the vitriolic acid.

- a. Blue vitriol, vitriolic acid and copper.
- b. Green vitriol, vitriolic acid and iron.
- c. White vitriol, vitriolic acid and zinc.
- d. Arsenic is found in a saline state, being soluble in boiling water, yields a regulus by sublimation with the principle of inflammability. Vide metals.

4. EARTHY SALTS, earth united with a mineral acid.

- a. Rock alum, vitriolic acid and argillaceous earth.
- b. Fixt sal ammoniac, muriatic acid and calcareous earth.
- c. Bitter

- c. Bitter purging salt, or magnesia, glauher's salt, or Epsom salt, vitriolic acid and magnesia alba.

III. I N F L A M M A B L E S.

THESE are not malleable or ductile; soluble in oils, but not in water, and readily take fire.

A. SULPHUR, formed of the vitriolic acid, united with the principle of inflammability, is found in all ores, except those of tin, bismuth, and cobalt. It is plentiful in strata of coal, and is always discoverable from the smell it emits.

a. Mundic, or iron pyrites, is sulphur mineralized with iron, and strikes fire with steel,

b. Marcasite, or copperas, stony sulphur combined with copper, iron, &c. strikes fire with steel.

c. United with earths, clays, and stones, sometimes in regular crystallised figures; or in round or square masses.

B. BITUMENS are either fluid or solid. Liquid bitumen issues out from crevices in mines, and takes fire by a candle.

a. NAPHTHA is a bituminous fluid, found floating on the surface of some waters, particularly in Persia, from whence it is chiefly procured.

b. PETROLEUM, rock or fossil oil, is thicker than the former, ouzes out of the crevices of rocks, whence it receives its name,

c. Pix judaica, or asphaltum, is of the same nature, but hard.

d. Amber, and ambergris, are formed of the principle of inflammability with the muriatic acid. The former is found principally in Prussia. Ambergris is met with in the greatest

quantities in the East Indies, at Madagascar, Mauritius, Borneo, the Molucca islands, and on the Egyptian coast.

- e. Jet is composed of wood united with the principle of inflammability.
- f. Coal, composed of argillaceous earth, vitriolic acid, and the principle of inflammability.
- g. Turf, mold impregnated with bitumen, interwoven with vegetable roots.

IV. M E T A L S.

THE most ponderous of all mineral bodies; fusible, but resuming their original properties when cold, even after calcination by the addition of the principle of inflammability.

- A. GOLD, when pure, is not sonorous, nineteen times heavier than water, soluble only in aqua regia, and hepar sulphuris, unalterable by fire.
 - a. It is most frequently found pure, in its metallic state, in thin plates, solid, crystallised, or in powder.
 - b. It is found in quartz, and in marcasite, and sometimes combined with iron, quicksilver, and a mixture of zinc and iron.

The largest quantities of gold are brought from the Brazils and the Spanish West Indies. This metal is found also in Hungary, Transylvania, and in many other parts of Europe, in red, yellow, black, or iron-colored sands. It is met with likewise in some rivers, as the Tagus, Ganges, Rhine, Saale, Niger, Danube, &c. called river, wash-gold, or gold-dust.

- B. SILVER, when pure, is eleven times heavier than water, soluble in the nitrous and vitriolic acids,

acids, but not in aqua regia; unalterable by fire.

- a. It is often found native or pure, generally of about sixteen carats standard.
- b. *Minera argenti vitrea*, or glass silver ore, of a dark color like lead ore, is ductile, and contains sulphur.
- c. *Minera argenti cornea*, or horn ore, resembling resin in color, and containing arsenic.
- d. *Minera argenti rubra*, red silver ore, a brittle red-colored ore, containing arsenic and sulphur.
- e. *Minera argenti alba*, white silver ore combined with arsenic, antimony, sulphur and copper, containing more copper than silver, of a light grey color, and of a dull steel-grained texture.

Silver is found in all countries, but most plentifully in America, particularly in Peru and Potosi.

C. COPPER, when pure, is near nine times heavier than water, the most sonorous of all metals, dissolves in all acids and alkaline solutions, oils and water. The least quantity of this metal in solution, turns blue by the addition of volatile alkali; united with calamine it forms brass; with tin, bell-metal.

- a. Native or virgin copper, malleable, fibrous; generally found adhering to other fossil substances.

Ziment copper, precipitated from the vitriolic acid; is granulated and friable.

- b. Mountain-blue, "Copper united with calcareous earth, dissolved and precipitated from an alkaline menstruum." Lapis lazuli is reckoned

an ore of this metal, from which ultramarine is prepared.

- c. Mountain-green, "Copper united with earth, dissolved by an acid."
- d. Glass copper ore, hard and brittle, usually found with native copper, of a purple or brown color.
- e. Grey copper ore, mineralized with sulphur alone, soft so as to be cut by a knife.
- f. Copper pyrites or mundic, yellowish or greenish; "Copper mineralized with iron, and frequently with a small proportion of arsenic; marcasitical." Shews the rainbow colors.
- g. White copper pyrites, "mineralized with sulphur, iron, and a considerable proportion of arsenic."

Copper ores are found in most countries, particularly in Sweden, Hungary, and Transylvania. Japan also affords a fine sort of copper.

D. IRON is about eight times heavier than water, is attracted by one of its ores called the load-stone; soluble in all acids, alkaline solutions, water and air. Its solution is turned of a black or dark purple color, by galls and vegetable astringents.

- a. In most clays and ochres, from which these earths and most precious stones receive their color. It may be even extracted from the ashes of most animal and vegetable substances by burning.
- b. Iron ochre, found in the fissures of iron mines, and at the bottom of chalybeate springs.
- c. Blood stone, or ruddle, (Hæmatites) red, brown or grey, containing a large proportion of iron, but is not attracted by the magnet.
- d. Crystalline

- d. Chryſtalline ore, reſembles marcasite, composed of ſhining cubical or octoedral particles, not attracted by the magnet.
- e. Common iron ore, ſolid, brown or dark colored. Is attracted by the magnet.
- f. Bluish ore, on the outside generally brown, attracted by the magnet, and eaſily melts.
- g. Magnet, loadſtone, or lapis lydius, mineralized with ſome ſulphur. Attracts iron, and points north and ſouth.
- h. Emery, from *σμερ*, or *σμερ*, to cleanſe or poliſh, contains iron, ſometimes copper, and even gold or ſilver particles.
- i. Manganefe, is a blackiſh friable ore, not attracted by the magnet.

The ores of ſome other metals contain iron; the copper ores uſually contain more iron than copper; it is alſo found in chalybeate waters.

E. TIN is a ſilver-colored metal, ſeven times heavier than water, does not vitrify like lead, is malleable and unſonorous, ſoluble in aqua regia, vitriolic and muriatic acids.

- a. Native tin, very rare.
- b. Cryſtallized tin ore, tin cryſtal or tin grains; mineralized by an admixture of arſenical earth; found in cryſtalline maſſes, commonly of a poliſhed ſurface, of a blackiſh brown color.
- c. Tin-ſtone, intermixed with a large proportion of arſenical earth and ſome iron.
- d. Mineralized with iron; and alſo with ſulphur and iron, called black-lead.

Tin is found in England, Bohemia, Saxony, and in Malacca in the Eaſt Indies.

F. LEAD is above eleven times heavier than water, unſonorous, malleable, and very fuſible, ſoluble in all acids and alkaline ſolutions.

- a. Galena plumbi, potter's lead ore, or lead ore, or lead glance, mineralized with sulphur, and a little silver, is a rich ore of lead, composed of flat planes, with cubic angles.
- b. Antimoniated lead ore, or lead trail, mineralized with sulphur and silver antimony, having irregular striæ, or radiated lines.
- c. Lead crystals, "Diaphanous, prismatical or pyramidal, mostly hexagonal," white, green, or yellow.
- d. Lead spar, "White or grey, often yellowish, without the least metallic appearance."
- e. Lead ochre, or native cerussa. "A white powder sometimes found on the surface of lead glance."

G. QUICKSILVER, or MERCURY, is a fluid metallic substance, fourteen times heavier than water, easily divisible, and evaporates in a heat below ignition, or before it becomes red hot.

- a. Sometimes it is found in a pure state, called virgin mercury, but this happens very rarely.
- b. It is chiefly procured in an ore united with sulphur, called cinnabar, of a red color, and brittle; sometimes combined with sulphur and copper, of a dark grey color, and brittle glassy texture.

Cinnabar is found in Hungary, Transylvania, Carinthia, Bohemia, the Palatinate, France, Spain, Sweden, and probably in the East Indies and Japan.

H. ANTIMONY is the metallic mineral, and the metal separated is called regulus of antimony; is a semi-metal of a silver color, consisting of brittle shining planes, above seven times heavier than water, soluble in aqua regia, and in spirit of salt.

a. Native,

- a. Native, pure, or regulus of antimony.
- b. Striated antimonial ore, mineralized with sulphur, of a grey color.
- c. Chrystallised antimony, of a crytalline appearance.
- d. Red antimonial ore, " mineralized with sulphur and arsenic, striated."

It is found in Bohemia, Saxony, Transylvania, Hungary, France, and other parts of Europe.

I. ZINC, or SPELTRE, is a bluish white semi-metal, seven times heavier than water, bears the stroke of the hammer longer than any other semi-metal; soon evaporates by heat. United with copper, it forms brass.

- a. Chrystallized zinc, a pure calx of zinc, of a grey color, resembling lead spar.
- b. Mineralized of various colors, with sulphur and iron, &c. as mock-lead, blend, black-jack, or mock-ore.
- c. Calamine stone, or lapis calaminaris, a calx or earth of zinc united with a martial ochre. Tutty, pompholix, and nihil, are impure sublimes or flowers of zinc, arising in the furnaces where zinc, or calamine, or compound metals made with them, are worked.

Zinc is found at Goslar in Germany, and at Holywell, and other places in England. It is also brought from the East Indies, in a pure state, called tutenague.

L. BISMUTH, or TIN-GLASS, is a semi-metal, of a white yellowish color, and laminated texture; above nine times heavier than water, and very fusible, soluble in the mineral acids, and in aqua regia.

a. It is found plentifully in Saxony, and in less quantities in England, but it is scattered in arsenical ores very generally. It is distinguished into native bismuth, flowers of bismuth, and bismuth ore.

L. COBALT is a semi-metal of a whitish grey color, fine grained texture, hard and brittle, about six times heavier than water; soluble in aqua regia, the vitriolic and nitrous acids, tingeing them red, after the dissipation of the arsenic from the cobalt. By calcination, zaffre, and the blue glass called smalt, are procured.

a. Black cobalt, "mixt with iron without arsenic, friable, in form of an ochre or a slag, hard and glossy."

b. Cobalt ochre, or cobalt flowers, mixt with the calc of arsenic, an efflorescence on cobalt ores.

c. Cobalt ore, "mineralized with arsenic and iron, solid, resembling steel, or crystallised.

d. Crystalline cobalt ore, "mineralized with sulphur, iron and arsenic."

It is found most plentifully in Saxony, particularly in the district of Misnia; but it is also met with in many other parts of Europe.

M. ARSENIC, wherever it is found, may be known by evaporation over the fire, as it gives forth a strong garlick-like smell, very noxious in a large quantity. (See Sect. IV. page 35.) soluble in acids, and even water by boiling.

a. Mineralized with sulphur, called yellow, or red orpiment. Sometimes it is united with tin, lead, silver, copper, or antimony. The richest silver ores abound with arsenic.

b. White

b. White mundic, white pyrites or marcasite, mineralized with sulphur and iron.

Arfenic is found principally in the Bohemian and Saxon mines; but the richest native orpiment is brought from Turkey and Natolia.

N. PLATINA, PLATA SILVER, OR PLATINA DE PINTO, introduced into England in the year 1749. Is eighteen times heavier than water, difficult of fusion, and hardens most metals on mixture; resembles silver in color. This metallic dross or recrementum is said to be found in the gold mines of the Spanish West Indies. Vide Lewis's Philosophical Commerce of Arts, Lehman's German Mineralogy, and Marcgraff's Opusculas.

O. NICKEL is a semi-metal, which was first discovered about the middle of the present century *; is about $8\frac{1}{2}$ times heavier than water; of a coppery color. It is found united with iron, arsenic, sulphur, and particularly with cobalt and bismuth. Its solution in the nitrous and muriatic acids is green. The vitriolic acid has little or no effect upon it.

a. Copper-nickel, "mineralized with sulphur, arsenic, and copper, resembles copper."

In the preceding observations on fossils, effervescence with acids, and striking fire with steel, have often been mentioned: it would be necessary, therefore, for a traveller in search of fossil substances, to have with him a bottle of aqua fortis, or the nitrous acid, and a steel, to discover thereby on the spot certain properties

* This metal was discovered by Cronstadt. See the Royal Academy of Sciences at Stockholm, for the years 1751 and 1754.

of such bodies as may be collected. A hammer also may be necessary to break stones, &c. that are too bulky to bring away.

A blow-pipe is likewise an useful article; by blowing long and forcibly through such an instrument, upon the flame of a candle, by which the point of the flame may be directed against the body to be examined, it will frequently discover whether it is a calcareous, vitrifiable, or refractory substance; and for greater precision, experiments for the same end may be afterwards made at the fire-side, on a charcoal fire, &c.

The collector should also attend to as many of the following particulars as possible.

1. When any article is collected, mark it by a number, or some sign of distinction, referring to a catalogue, with all the particulars that may be known relative to it; as,

2. Where it was found.

3. In what quantity, whether scarce or abundant.

4. If on the surface of the earth, or at what depth.

5. In what position, whether horizontal, perpendicular, &c. And with what other fossil bodies it was found, as clay, stone, slate, mineral, &c.

6. Whether in strata, or in loose nodules.

7. The depth and thickness of the strata, how they incline, or to what points of the compass they tend; or if level or horizontal; whether they have perpendicular or horizontal fissures, and what fossil bodies are contained in these fissures.

8. All high mountains and hills, especially their sides, are to be searched; the shores also of
the

the sea, with their banks, and the cliffs adjacent, and the falls of cascades, rivers, and great gullies.

9. The situation of mines, pits, and quarries, whether in a valley or hill; and the disposition of the strata, whether horizontal, inclining, &c. their thickness, and the depth they lie, and what other fossils are imbedded either in the strata, or in the neighbouring caverns, fissures, partings, &c.

10. The waters of mines should be examined, whether pure, tasteless, purgative, vitriolic, or chalybeate, &c.

11. The damp and steams of mines, and what are the consequences or effects of them; in what seasons and state of the air they are chiefly observed; and what temperature the air bears in different depths of such mines.

12. The account given by the natives, inhabitants, miners, workmen, &c. who may be acquainted with the subject.

S E C T. VII.

*Directions for taking off IMPRESSIONS or
CASTS from MEDALS and COINS.*

—————Et cætera penè gemelli.

HORAT. Ep. X.

CHIEFLY owing to the cost required for purchasing a cabinet of medals, it has happened that the study of them has hitherto been confined, comparatively, to a few individuals. Another principal impediment to the cultivation of an acquaintance with them, has arisen from the difficulty of understanding the inscriptions, for want of a sufficient knowledge of languages; on which account in particular, this study has been condemned by the illiterate as barren and useless; but such as are acquainted with the advantages which have already resulted from those *nummi memoriales*, cannot hesitate a moment to assist a promotion of a more general pursuit of the subject (g).

While Colossian statues, and the hardest marbles, with their deepest inscriptions, are destroyed by accidents, or by time, and paintings finished with the highest colors quickly fade, a medal shall survive innumerable accidents, and disclose historical facts a thousand years after statues are crumbled away; and when nothing but the names of an Apelles or a Praxiteles remain. Does not a single medal, of

(g) Though the study of medals does not properly belong to natural history, this short account of taking impressions from them, may prove acceptable to some travellers.

which

which we are in possession, give us greater light into history, than the once famous libraries of Alexandria and Pergamus, which are now no more? From these, and many other considerations, I would willingly contribute my endeavours to render this study more general, and consequently more useful. I have tried a variety of methods to enable a young medalist to collect a cabinet, which may initiate him into the knowledge of medals and coins at a trifling expence.

The method of taking off plaster of Paris and sulphur impressions, is known to every body: the first is too soft to preserve them from injury, and the brittleness of sulphur is a greater objection.

I found by forming a coat or layer of thin metal over the plaster of Paris, it would be a considerable defence. Tin is the cheapest and most convenient metal for the purpose, as it is sufficiently flexible, and at the same time very much resembles silver. The tin-foil I have tried, is of the same kind with that used for silvering looking-glasses. It should be laid over the medal or coin intended to be taken off, and then rubbed either with a brush, the point of a skewer, or a pin, till it has received perfectly the impression of the medal; the tin-foil should now be pared off round the edge of the medal, till it is brought to the same circumference: the medal must then be reversed, and the tin-foil will drop off into a chip box or mould ready to receive it, the concave side of the foil, or that which is laid on the face of the medal, being uppermost; upon this pour plaster of Paris made in the usual manner, and when dry, the figure may be taken out
of

of the box or mould, with the tin-foil sticking on the plaster, the convex-side being now uppermost again, in which position it is to be kept in the cabinet, after it becomes dry. To have an impression very perfect, the thinnest tin-foil should be made use of (*b*).

The impressions taken in the foregoing manner almost equal silver medals in beauty, and are very durable: if the box or mould (*i*) be rather larger than the impression of tin-foil, the plaster, when poured on, runs round its edges, and forms a kind of white frame, or circular border, round the foil, whence the new-made medal appears more neat and beautiful. If this tin-foil be gilt with gold-leaf, by means of thin isinglass glue, or boiled linseed oil, the medal will resemble gold.

(*b*) This method does not in the least injure any medal or coin.

(*i*) Chip boxes, used by apothecaries, answer this purpose, and may be easily procured. A slip of paper wrapped round any circular body with a flat surface, is equally convenient.

ment to persevere in pursuits so worthy of a rational mind.

It would render natural history much more pleasing, as well as greatly tend to its progress, were the limits of our knowledge therein precisely ascertained, that travellers and curious persons, who have little leisure for reading, might not only be informed of what is already discovered, but also of what is still doubted, or unknown; by which means their inquiries would be better directed, and more conducive to real information and useful discovery.

From these considerations, I imagined that the following queries and observations would tend to promote the original design of this publication; which, though a work of considerable labor and attention, is submitted with due deference to the candour of the public. If the experience of the author, or the information of his friends, should hereafter afford him a more extensive and intimate acquaintance with the subjects recommended, he would retract a mistake with as much readiness as he would communicate any future discovery.

S E C T. I.

*Observations and Queries respecting Learning,
Antiquities, Religious Rites, polite Arts,
&c.*

Ingenuous arts, where they an entrance find,
Softens the manners, and subdues the mind *.

i. **T**HE alphabets of the various nations, their pronounciation and numeric value, with their numeric figures, if different from the letters of the alphabet, and books written in each language, especially grammars, dictionaries, &c. with the dates of each when written, merit the investigation of the curious; likewise the materials used for writing, and their preparation, as the methods of making ink, paper, and pens, and of sizing and glewing the paper; the art of printing, and the contrivances for doing it.

2. Manuscripts, in good preservation, of the Hebrew bible, or parts thereof, particularly if upwards of 300 years old.

3. Books containing the religious principles of any nation or people, and which usually are written in a dialect different from that which such people now speak, or in a poetical, high metaphorical style, and therefore understood by few only, and for the most part kept very secret; amongst these we may enumerate the Chartah Bhade Shaitah of Bramah, the Chartah

* ————Ingenuas didicisse fideliter artes
Emollit mores, nec finit esse feros.

OVID. Pont.
Bhade

Bhade and Aughtorrah Bhade Shaftah, the Vedam (*b*), the sacred books of the Persees, written in the ancient Persian dialects, called the Zend, and Pehlvi (*c*); the Koran of Mahomet; the sacred books of the Mendæans or Sabaites, at or near Bassora in the Persian gulph; the voluminous sacred books of the Lamas in Nexpal and Thibet called Khangiar, and its mystic part termed Riuté; the sacred books of the priests in Pegu and Siam, and others of similar tendency. These would be still more valuable, could English, Latin, or French translations be added.

4. Descriptions of the manners, customs, feasts, and religious ceremonies of the respective nations; the architecture both exterior and interior of their temples, religious, public and private buildings; the figures, names, genealogies and ranks of their divinities and idols; their sacred and domestic utensils, the casts and ranks of people, the learning and religious tenets of each nation, to all which explanatory drawings would be required. What nations use circumcision, and what are the advantages derived from such a custom, or disadvantages from the omission of it? Is circumcision ever extended to the females, and in what manner is it employed?

5. The translations of the bible in different languages; and the sacred books of Christians of various denominations, as the Georgian, Ar-

(*b*) In the peninsula on this side the Ganges, the sacred books of the Bramins are contained in the Vedam, copies of which in the original Sancrit character, would be very valuable.

(*c*) The Pehlvi is a more modern dialect.

menian, Persian, Æthiopian, Coptic, Arabic, and Syriac, especially among the Christians on the Malabar coast, and in the isle of Socatora (*d*).

6. The history and succession of princes, the origin and migration of nations; the government and political constitution of each country; the causes of the increase or decay of power.

7. A relation of the private and domestic life of the people; the customs observed at the birth of children; the marriages, sepulchral rites, and any other circumstances characterizing each nation.

8. An account of the astronomy and chronology of different nations, whether they observe the system of the seven days of the week, the names for these days, with their signification. The number, names, and significations of their months; the number of these in a year; whether they are used to conciliate the moon's and sun's motion by any intercalation, or a certain cyclus of years; the names for particular stars and constellations in the zodiac, with their significations; the distinctions of the other stars from the planets, with the length of their revolutions.

The state in which the art of drawing, carving, and engraving in stones has been, or now is. Specimens, drawings, or collections of old inscriptions, engravings, seals, gems, statues, carvings, basso and alto relievos, and the places where each of the above monuments are found, the size, substance whereon it is worked, &c. the ancient and current coin, with the exact valuation.

(*d*) The Nestorian Christians formerly had a settlement among the Indians on the Malabar coast, and were there very much respected. Are some of these still existing? Have they any ancient Syriac books?

S E C T. II.

Commerce, Manufactures, Arts, Trade, &c.

Jove has the realms of earth in vain
 Divided by th' inhabitable main :
 If ships profane, with fearless pride,
 Bound o'er the inviolable tide (*e*).

FRANCIS.

DEscriptions and drawings, of the looms, tools, machines, &c. employed in manufactures, particularly if simple, ingenious, and gaining time or strongly increasing power, might prove highly beneficial.

2. An account of the planting, gardening and agriculture of each country; the manure used, the time and labor employed in each branch of business; the price of labor, the implements of agriculture; the kinds and quantities of corn sown in an acre, the quantities reaped in different soils; the proportion of vineyards or pasture lands to arable, and the number of people in a square mile of pasture, arable lands, vineyards, or any other kind of plantation.

3. The kinds of pigments, stains, and dying materials known and used, particularly in China; are they mineral or vegetable? the manner

(*e*) Nequicquam Deus abscidit
 Prudens oceano diffociabile
 Terras, si tamen impiæ
 Non tangenda rates transiliunt vada.

HOR. l. 1. Od. 3.

of preparing and applying them, with the advantages and disadvantages of each sort compared with ours; particularly the materials, machines and methods employed by the Indians for dying, staining and printing their chintzes, calicoes, &c.

4. The wood and timber used for ship building; the form and construction of the ships; the wood employed for masts; the succedanea for oakum, ropes, cables, sails, pullies, &c. with the comparative advantages and disadvantages.

5. The means devised for catching quadrupeds, birds, fishes, shells, &c. either for food, or to prevent the increase of such as are noxious to the people or their plantations; are any animals made tame and employed to catch others, or are any methods used for killing or inebriating them?

6. The materials of cloathing; if animal skins, the manner of dressing them; if the hair of animals, or the threads of certain insects, the method of spinning, twisting and weaving such substances; if vegetables, how are they cultivated, dressed, spun and manufactured? The cut and make of the dresses in general, with the advantages and disadvantages of each particular part.

7. The various objects of commerce in general, the growth and manufacture of each article, with the names by which it is known, and its uses when designed only for inland trade; the price of labor, and the number of people employed in each department.

8. It is a common opinion, that large quantities of remnants and rags of all kinds of scarlet cloth, are yearly carried from England to China, and that the Chinese extract from them their fine red pigments. If this be true, what methods are employed to extract the color?

9. It has been observed that analogous substances are most proper for dying homogenous bodies (*f*); thus animal substances are best for dying wool and silk, because wool and silk are animal substances. A blue dye, made of woad (*Isatis* of Linnæus) is found to be full of insects. Is it not the same case with indigo? Are not all the lasting dyes made from animal substances, or of such as contain numerous insects?

10. The manner in which the best indigo is manufactured in the interior parts of Indostan, and the plant from which it is made. Is it from the *Indigofera* or the *Anil*? Are there any rules to ascertain when the plant has soaked sufficiently, and how long it ought to be beaten?

11. Is there any linnen made of flax or hemp, or what other substances are spun and wove in India besides cotton? What use is made of the yellow or brown cotton taken from the *Bombax*? Is it manufactured for apparel, and appropriated for a certain order of men, as priests or Bramins?

12. Descriptions and drawings of the instruments and machines employed by the Chinese and Indians to clean the cotton from the seeds.

13. Is only European zaffer from cobalt used by the Chinese for painting their porcelain

(*f*) Vid. *histoire de l'academie*, an. 1768. art. 11.

blue, or have they some of their own? If they have, what name is it known by, and how is it manufactured? It is probably finer than ours, from the richness of the old China figures.

14. The preparation of the pickle or catchup called Soya; is it made from the *Dolichos Soya* Linn.? Is salt, wheat or barley added, and in what proportions?

S E C T. III.

Metereological Observations, Food, Way of Living, Animal Oeconomy in general, &c.

For every man to native custom prone,
Conforms and models life to that alone.

GOLDSMITH.

IT is always satisfactory to have regular meteorological accounts by the assistance of a good barometer and thermometer; and to observe at the same time the quarter the wind blows from, and its degree or violence; the quantity of rain and snow by inches; the size of hailstones; the appearance of aëreal phenomena, as auroræ boreales or northern lights, fiery globes, halos or bright circles round the sun and moon; with the effects likewise of thunder storms, lightening, &c.

2. The traveller should also remark the succession of seasons, and the various fruits and productions of each country; the times of sowing or planting, as well as of harvest, or of reaping the grain, &c. the budding or flowering of trees, or shrubs. The food of the inhabitants, and the preparation of it previous to its use.

3. Some account might be collected of the general prevailing diseases in different seasons, and the causes producing the same, or the remedies employed for curing them, and the methods in which such remedies are administered.

4. Are

4. Are any diseases caused by the effluvia of certain trees or plants, or is the touching, handling or cutting of trees or plants ever suddenly prejudicial to health? Does the effluvia from spice trees or the frankincense tree prove deleterious?

5. What are the effects or symptoms, which arise from the bite of poisonous snakes, or any reptile or insect? Has the bite of a snake ever been found to have a salutary effect in curing a certain previous disease, or does the bite of one snake, ever destroy the effects of another? Are there any counterpoisons or antidotes usual against the bite of snakes? Is musk or any species of the aristolochias a remedy which the snakes avoid and fly from, or do any of these prove lethal to snakes?

6. Is the *pedra de cobra* used as an antidote against the effects of the bite of any snake, and with what success? How is this remedy procured and applied?

7. The manner of managing domestic animals, whether in health or otherwise. The animals which the natives in any country castrate, and the effects produced by it; as well as the period when such a custom was first introduced.

8. It would deserve remarking where and in what manner Polygamy is introduced, whether perpetual or temporary, and the effects of it upon the manners, religious or civil customs, population, &c. of such countries. Does Polygamy prevent some men from procuring wives, or are the women brought from neighbouring nations? Is it any where customary for one woman to be married to several husbands during the life of the first?

9. Accu-

9. Accurate calculations of births or burials in provinces or towns, and the proportions of males to females, would prove very valuable.

10. Have any buildings or ships furnished with electrical rods after Dr. Franklin's method, ever received any injury from lightening?

11. Is the venereal disease cured without mercury? and if so, by what remedies?

12. What diseases attack the workmen employed in different kinds of manufactories?

S E C T. IV.

Zoology.

Non ad unam natura formam opus suum præstat;
sed in ipsa varietate se jactat.

SENECA Quæst.

1. **I**T would greatly tend to improve our knowledge in this department of natural history, were the following remarks respecting quadrupeds to be carefully made; viz. the general times of couplng, and of gestation; how many young are brought forth at a time, and how often during one season; at what period of life they become prolific or barren; where their principal resort and dens are; whether the males assist the dams in providing food for the young of the carnivorous tribe; how long these are under the protection of the old ones; and what age each species attains.

2. It might be enquired whether any person hath ever seen elephants in copulation, which has been hitherto denied; it is said that if the wild elephants perceive any body, they immediately begin to rave, and cease not till the curiosity of that person has been rewarded with death; and though the Indian princes have kept great numbers of tame elephants of both sexes, they never could procure a breed from them. What differences are there betwixt the African and Indian elephants? Is the structure of the grinding teeth equal or flat in all, or have some elevated or pointed crowns, similar to those of carnivorous animals? Do elephants ever shed their tusks or teeth, or are they permanent?

3. How

3. How many species of tygers so called, or more properly of leopards, panthers, ounces, &c. are there in India, and what are the stated and perpetual marks for distinguishing each, in different periods of life? What other animals of the feline kind are found in India, with the specific characters of each?

4. Does the shakal or jackal (*Canis aureus* Lin.) bear any resemblance to an animal commonly called the cross-fox (Pennant's Syn. Quadr.) What animal do the Arabian writers call banat-el-auvi?

5. Are armadilloes (*Dasydotes* Lin.) in Asia or Africa, in what parts, and which are their characteristics?

6. There are many species of the jerboa (*Mus jaculus* Lin.) and probably if they were known, a separate genus might be formed: an animal as big as a greyhound, weighing about eighty pounds, and hopping on two legs, was discovered on New Holland by Drs. Banks and Solander; it would prove a considerable acquisition in natural history to learn the characteristic of this genus, the number and disposition of the teeth, the species, general œconomy and manner of living, of these animals.

5. When the various species of the feathered tribe begin to couple or pair should be noticed; when, where, and of what materials each bird builds its nest, with the color, size and number of eggs; how long the eggs are in incubation; what the young are fed with, and at what periods are they fledged; with the distinctions between male and female birds in different seasons and ages.

6. The

6. The migration of birds should not be disregarded, but their merely disappearing in one part of the country is not properly a migration, for we frequently find that birds shift their place of abode, at certain seasons, on account of some palatable food, which may be more plentiful in one part than in another; the crossing wide seas, or extensive continents is understood. If any bird be found out at sea, the species of bird, the direction of its flight, the distance from land, and the latitude and longitude should be noted.

—————In figure wedge their way,
 Intelligent of seasons; and set forth
 Their airy caravan, high over seas
 Flying, and over lands; with mutual wing
 Easing their flight: So steers the prudent crane
 Her annual voyage, borne on winds: The air
 Floats as they pass, fann'd with unnumber'd
 plumes (g).

In northern climates, it would be useful to observe when swallows are first seen, and when they disappear; and likewise in what climates they have been found, whether in a torpid or active state, with the species and peculiar characters.

7. What birds are allowed a privilege or immunity from being injured or killed? and what may be the reasons for the same, or the advantages derived therefrom?

8. Some birds of prey are employed in the east by the Grandees in hawking and hunting. What means are used for teaching such birds, and what are their differences, size, figure, plumage, names, specific characters, &c?

(g) MILTON.

I

9. What

9. What are the character, plumage, food and œconomy of the Indian ravens (*Buceros* Lin.)

10. Are there any humming birds (*Trochilus* Lin.) in the Indies or China with a filiform long tongue consisting of two femicylinders?

11. What are the peculiar distinctions of the true wild peacock? Are there any white peacocks in India, and of a separate species? Is the change in plumage obvious in wild peacocks, or is this the result of domestication? Do white peacocks breed with grey and green ones, and what is the color of the young breed?

12. Where is the *Hirundo esculenta*, Linn. found, and of what substance is the nest composed, which is so much in request with the Chinese and Europeans? Is it made from some molluscæ or seaworms, as Kæmpfer says; or from fish spawn, as M. le Poivre author of the *Travelling Philosopher* affirms; or from sea weeds, agreeable to what Dalrymple relates? Where is the nest fixed, and what is the specific character of this species of bird?

13. Is there to be found in the Indian seas a *Jaculator* fish, *Sciæna Jaculatrix* (b), different from the *Chætodon rostratus*, Linn? or is the faculty of shooting at insects with a drop of water peculiar to these fish, or common to any others?

14. Has the *Raja Torpedo*, Linn. or the cramp or numb-fish, the same electric qualities as the *Gymnotus electricus*?

15. As there is not yet one good figure of the sea cow (*Trichechus Manatus* Lin.) it

(b) *Philosophical Transactions*, Vol. 54. and Vol. 56. t. 8. p. 186.

would

would be desirable to procure a good drawing of it while alive, to have it dissected, and to observe wherein it coincides with, or differs from other animals nearly related to it, as the seal, dolphin, &c.

16. The seasons should be noticed, when different species of fish spawn, and the rivers, bays, shoals, or sands they resort to for that purpose; what age they attain before they spawn, the food they eat, the age they live to as accurately as possible, the size they acquire, and the latitude wherein they are generally found; the method of catching them, and to what uses also they are applied when caught, and whether they are esteemed wholesome food or the contrary.

17. Which species of moth or butterfly is it, the caterpillar of which in China affords that strong grey kind of silk, and how is it manufactured or wore? How are these silkworms or caterpillars preserved, fed and managed? The introduction of such a new silk into England would be a useful acquisition, and redeem entomology from the censure it is now branded with, of being a mere curiosity void of any real utility.

18. Are the insects which are said to collect the Lac or Gummi Lacca from the *Croton lacciferum*, Linn. bees, ants or wasps? Are they wild, or domestic, and the property of certain persons? and how are they managed and propagated? Vid. sect. V. 18.

19. Are there any rattle-snakes in the Indies or China, or in any part of the world besides America?

20. The various bundles of swimming sea weeds ought not to be neglected; for besides the different kinds of fuci they consist of, they generally contain small crabs, shrimps, or other submarine insects or worms, such as the onisci, monoculi, sometimes shells and escharæ, fertulariæ, and other corallines.

21. The various animals inhabiting shells deserve investigation, as there are probably new genera yet to be discovered: It is not fully ascertained whether the inhabitant of the paper-nautilus be an animal really belonging to that shell, or only uses it in the same manner as some crabs do other shells; neither is it known whether or no the paper-nautilus animal, or the sepia, increases or enlarges its shell. Indeed the generation, and general œconomy of all the mollusca class is very imperfectly known.

22. Experiments might be tried to ascertain whether pearls are not such concretions in the shells wherein they are found, as the crabstones (*Lapides seu oculi Cancrorum*) in the shells of the river cray-fish, which collect alkaline or calcareous materials from the food of the animal for the formation of the new shell, as do the *Mya* and *Mytilus margaritifer* a new layer for the increase of their shells. Do the shells containing the pearls gradually increase through the year, or at a certain season only?

23. It should be carefully remarked which of the shells, especially of the *Murex* and *Turbo* kinds, afford a red or purple juice fit for staining or dying like the purple of the ancients; whether the dye be permanent, and the method of preparing and applying it by some Indian nations. D'Ulloa, in his South-American voyage,

age, Vol. I. page 182. speaks of one of these shells found near Panama on the Darien Isthmus; and Janus Plancus, or Giovanni Bianchi, in his work on shells, mentions the *Turbo scalaris* Lin. or *Wendeltrap*, as affording the violet purple of the Romans.

24. Descriptions and drawings of the animals or polypes inhabiting the various corals, coral-lines, sponges, Echini or sea-eggs, *Asteriæ* or star fish, *Sepiæ* or cuttle fish, *Holothuriæ* or sea nettles, and all the various mollusca, and the polypes of the Tubipores, Madreporcs, Millepores, Cellepores, &c. deserve the attention of a natural historian, as but few of them are well described or known.

S E C T. V.

Botany.

Itaque ista quoque naturæ rerum contemplatio, quamvis non faciat medicum, aptiorem tamen medicinæ reddit.

CELSUS.

1. **T**HE seeds of almost all the Indian plants are worth collecting, they may be preserved in the manner prescribed in sect. III.

2. What trees bear the Myrobalans, a drug formerly much in request, but at present in little esteem as a medicine, but which might probably afford some use in dyeing? What species of trees bear the Myrobalans bellirica, chebula, citrina, and indica or nigra; whether a kind of Phyllanthus as the Myrobalanus emblica? The use also of the same in India?

3. Is the aloe-wood or Eagle-wood, the Calambac, and the Agallochus, the same or different? The place from whence procured, with the generic and specific characters?

4. Is the Orchel or Rochel (Lichen roccella, Lin.) which is found in Madeira, and used to dye red, a kind of Lichen or a Zoophyte? Is the steeping it in putrid urine sufficient to prepare it?

5. Where does the Lignum Rhodium grow? Is it a kind of Nyctanthes or Indian Jasmine?

6. Of what genus and species is the Tea-wood, of which tea chests are made?

7. What is the wood Tek on the Malabar coast, of which the Indian ships are built? Is it
a fact

a fact that it never is attacked by sea worms (Teredo, Lin.)?

8. The various kinds of pulse, as pease, beans, phaseoli, &c. especially such as are reared at the Cape of Good Hope, and exported to the Indies; the other fruits likewise which are cultivated at the Cape, and taken in as refreshments on board the European ships.

9. The various plants in the gardens of the Dutch East India company, with the methods of cultivating them, are worthy to be noticed; and the indigenous should be distinguished from those imported and naturalized; whether there are Clove, Nutmeg and Cinnamon trees, with their height, leaves, and general characters; and what species of tree is the Muscadine of the Indies, cultivated at the Cape.

10. The different kinds of Palm trees, their nature, soil, characters, names given by the natives, and the uses they put them to, or their fruits, leaves, bark, pulp, &c.

11. To what genus and species does the grass called Tatak belong? and where does it grow, besides Madagascar, Java, the Malay Islands, and the French Isle de Bourbon? The grasses in general which thrive in particular countries and climates, with the soil and culture, and the kinds of cattle most addicted to each.

12. What plant bears the famous Indian nut, which is used as a restorative, and is immensely dear, being sold according to some at three thousand pounds apiece; the place where it is cultivated, the soil it requires, and its real or imaginary virtues?

13. The Columbo root called by the Portuguese Raiz de Mozambique, is a native of the

continent of Asia, but it has been transplanted to Columbo in Ceylon, and the Dutch now supply all Asia with it. Is it different from the root of Lopez or Lopezia; and if so, what are the characters of each?

14. A description of the small grains and Phaseoli, with which the Indians on the Coromandel coast sow their fields after the rice harvest, with the minutiae of their cultivation, especially the machines employed for watering the grounds.

15. A tree or plant in Cochin China called Tfai, on being fermented like Indico, plentifully furnishes a green colored flour, which in dyeing gives a lasting tincture of a fine emerald; it would be therefore worth enquiring after the method of extracting the color, and the additional substances employed in fixing it, and what stuffs are best fitted to receive the same.

16. Are the stamina of the *Pterocarpus Draco*, Lin. which is called *Draco arbor siliquosa populi folio*, by Commelin, and *Lingoum* by Rumph. Amb. 2. t. 70. connected or separate?

17. Which genus of plants does the true Ebony belong to? Is it an *Aspalathus*?

18. Is the *Croton lacciferum*, of which certain insects are said to make or extract the Lac or Gummi Lacca, found in China or Coromandel; and do the insects really employ the plant for this purpose? Vid. sect. IV. 18.

19. Many varieties of Rice are found in India, as the Red with red husks; the little Rice small grained, oblong and transparent; the great long Rice with round grains; the dry Rice which grows best on a dry soil, and requires

quires no watering; and the common Rice; are these various kinds of Rice different species or varieties only? The culture, characters, and specimens of each, if different, would be necessary.

21. There is an elastic gum, called Borrachio in Portuguese, and Kaoutchuck in the language of the natives near Cayenne in South America, of which it is said the Chinese make elastic rings for lascivious purposes, but here used by surgeons for injecting liquids, and by painters for rubbing out black-lead-pencil marks. Is this gum manufactured in India or China, and from what plant, and in what manner, with the different uses it may be applied to? Is the plant an Euphorbia or Apocynum?

22. What plants produce Gum Myrrh and Gum Ammoniac, and how are they collected?

23. What plant affords the Gummi rubrum astringens from Gambia?

S E C T. VI.

Minerology.

And join both profit and delight in one *.

CREECH.

1. **T**HE manner of working mines, and the methods employed in getting, breaking and extracting the ores; the tools and machines employed for each of these purposes, are subjects worthy of enquiry. Is gunpowder ever used to blast the stones or ores? The manner in which the ore or metal is found under ground, whether in perpendicular veins, or in vicinity to them; in horizontal flat strata, loose pieces, or in solid continued bodies; in what kind of stone, and at what depth; the means of carrying off the water when present in the mines. The vapors found in them, whether mephitic and noxious, or inflammable when fire or light comes in contact with them.

2. The manner in which white copper, resembling silver, is manufactured, and the various processes whereby it is done.

3. The operations used in extracting the metals from the respective ores, with specimens and names of the ores, and the places where they are procured; the products yielded from the ores by fusion; the fluxes added to promote fusion, or the substances to prevent volatilization, and whatever is subservient towards

* Simul et jucunda et idonea dicere vitæ.

HOR.

refining

refining of metals or reguluses; with the structure and materials of the ovens, the fuel and quantities of it employed, the time for each operation, and the preparatory cautions, including the picking, pounding, washing, sifting, and ustulating of the ores; and drawings of the various machines and tools used for each purpose.

4. The places from whence the various gems or precious stones are procured, with their prices on the spot; the ground and strata wherein they are found, and the figure or form of each kind before being cut, whether determinate and general, or accidental.

5. The manner of manufacturing those immense quantities of salt-petre annually exported from the East Indies; the soil employed for the lixivium, and the manner of preparing the soil. Are any animal or inflammable substances added to it? By what means is lixivium precipitated? Is an alkali used for that purpose, and how is the alkali procured? Is any use made of the remainder of the lixivium after the precipitation of the salt-petre? Is the lixivium boiled, and inspissated by fire for the crystallisation, or by the heat of the sun?

6. If borax be artificial, in what manner and from what substances is it made? If native, in what strata and soil does it lie in?

7. How far has the knowledge, value, and use of metals extended amongst nations?

THE END.

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